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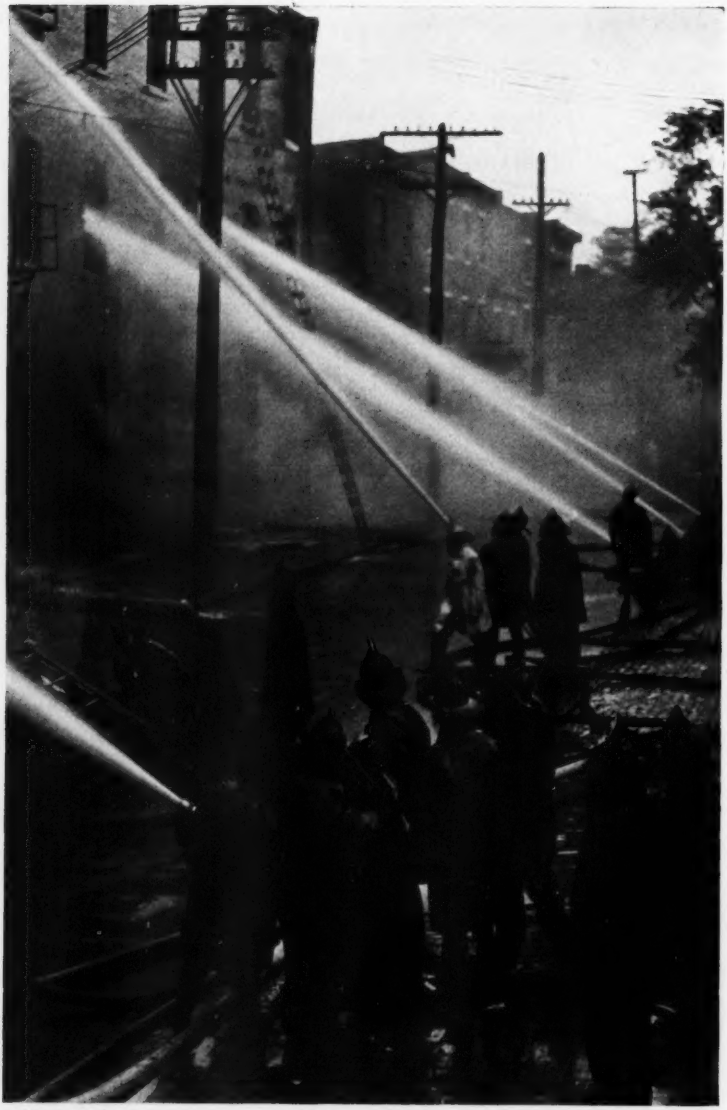
Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



H. Armstrong Roberts.

Millions of gallons of water may be necessary for the extinguishment of a fire that could have been put out with a pail of water applied at the right time and place. **(See article on page 266.)**

The Quarterly

Vol. 25 January, 1932 No. 3

City Fire Prevention Bureaus. One of the most satisfactory and perhaps the most important of the developments in organized local fire prevention effort has been the growth in recent years of the fire prevention bureau as an integral and vital part of the municipal fire department. A review of the past ten years shows the substantial progress that has been made in this field. Ten years ago approximately twenty of the larger cities maintained some sort of fire prevention bureau organization. In nearly every case the bureaus in these cities have been enlarged and additional scope and powers provided. New bureaus have been created in at least fifty cities since 1921. Seventy fire prevention bureau chiefs are now included in the Fire Marshals Section of the N.F.P.A. Our engineers have been directly responsible for arousing interest leading up to the establishment of bureaus in at least twenty cities in the past five years.

We believe that there is nothing a city can do that with a relatively small expense will reduce fire hazards and losses throughout the city more than by the creation of a fire prevention bureau with proper authority to carry out its duties.

* * * * *

The 1931 Fire Loss. Fire losses for the year 1931, according to the preliminary estimate given on another page of this QUARTERLY, indicate a substantial reduction from 1930. A variety of factors may be responsible for offsetting the usual effect of business depression upon the fire loss, and it is probable that no single factor should receive all the credit. The deflation of commodity values, with consequent decrease in the money loss for a fire of the same physical magnitude and decreased inventories are doubtless significant factors. The most important factor, however, has probably been the vigilance of fire protection authorities.

It is only within the past few years that fire prevention bureaus and arson squads have been widely established, and the present depression is the first such period in which the fire prevention function of municipal fire departments has been so organized as to exert a material influence upon the national fire loss figures. The capable fire chief knows the danger spots and can concentrate the efforts of his fire prevention bureau upon them. Experience shows that with uniformed inspectors going through a property at frequent intervals, the fires that the chief has feared seldom occur.

With an efficient arson squad investigating every fire that is in any way suspicious, the would-be incendiary realizes the futility of attempting this crime. The conspicuous results in some cities in which the fire prevention functions of the fire department have been particularly well developed show clearly the effectiveness of the measures for which the N.F.P.A. has been working, and make it reasonable to assume that fire prevention bureaus, arson squads or other effective means of fire investigation, and correlated educational programs, are now sufficiently widespread as to have a very noticeable influence upon the national fire loss. While fire losses in general have decreased, the losses on dwelling property have been showing an upward trend. It is not practicable for fire departments to extend their fire prevention functions into the individual home, except as the householder may be reached in a general educational campaign, and the fact that losses have increased in the dwelling occupancy, while decreasing in commercial and industrial occupancies, points to the effectiveness of fire prevention efforts in the business properties where their influence is principally felt.

* * * * *

Fire Department Economies. The trend of municipal budgets lags behind general business, but it seems probable that in the coming year there will be an increasing demand for the reduction of municipal expenditures, including those for fire protection. Reduction of fire department cost in any direction, without serious impairment of vital protection, presents great difficulties, but whatever the method used it should not be at the expense of the fire prevention bureau and arson squad, whose work is of very great importance, particularly at the present time.

As a practical matter it does not seem possible to make any drastic reduction in fire protection expense without inviting such increased losses as to far outweigh any possible savings. A major conflagration at this time would be not only a local calamity, but would have far reaching effects upon general business conditions and might exert a serious world-wide influence. Any major conflagration would mean extensive sales of securities by insurance companies in order to pay their losses. It is not difficult to picture the disastrous effect of even a relatively small amount of additional forced liquidation at this time upon security markets, credit and general business conditions.

* * * * *

Taxes for Fire Protection. Fire departments when first organized were privately maintained by the insurance companies. This was at an early period recognized as an inequitable method of supporting a public function that clearly inured to the entire community, a tax upon the prudent citizens who carried fire insurance that benefited alike the

careless and improvident. Though inequitable taxes upon fire insurance still persist, the municipal fire departments of the United States and Canada have since an early period been supported from the general tax levies assessed against the real and personal property benefited by fire department protection. In the days when practically all buildings were of combustible construction, and when there was no marked differentiation in hazard or protection between the various buildings of a city, a fire department assessment on the basis of the assessed property valuation was doubtless as equitable an arrangement as could be devised.

Like many institutions surviving from an earlier age, the present method of assessing the cost of fire protection seems wholly illogical, and in some respects contrary to the best public policy. The largest taxes are paid by fire-resistive and sprinklered buildings; that have the smallest need for public fire protection. Why should the prudent citizen who erects a fire-safe building pay a heavy tax to support a fire department whose principal function is to protect hazardous structures that are of very low value and which make a relatively small contribution to the aggregate tax levy? The present system tends to penalize the provident members of the community and to discourage fire-resistive building construction and improved fire protection.

Some portion of the expense for public fire protection—the cost of that portion of the fire protection system that would still be necessary to public safety if all the structures in the city met the best standards of construction and protection—should clearly be a charge against the entire community, and can fairly be assessed as a part of the general tax levy. The balance, perhaps a half or more of the total, represents the cost of protection for combustible buildings and unsprinklered hazardous occupancies, existing hazards that would not be duplicated in new construction under the terms of modern building and fire prevention code requirements. Equity demands some new method of assessing this part of the cost, some method based upon hazard or combustibility, rather than upon value. At first glance this might seem to involve great difficulties, but there is no reason to believe that once some such method were established there would be any greater trouble in its application than in the case of tax assessment on the basis of property value, which despite its inherent difficulty has proven a workable method over a long period of years.

If half the fire protection tax could be assessed on some such basis as on cubic feet of combustible material, there would be a powerful incentive to reduce assessments by replacing combustible by fire-resistive construction and eliminating hazards by sprinkler protection. Such a tax plan would operate to accelerate the present tendency towards increased fire safety, and bring nearer the time when the combustibility of cities may be so reduced as to require only a fraction of the present expenditures for municipal fire protection.

Fire Protection by Contract. Public utilities have greatly reduced the cost of such services as electricity and gas by combining the original one-town companies into large organizations serving extensive territories. Fire protection, now operated primarily as a single city unit, would seem to offer possibilities of similar economies, particularly in densely populated parts of the country where the fire departments of several adjoining communities might be operated as a single unit with more effective protection for the entire territory. Combination of existing fire departments of separate political entities would involve many practical difficulties, but the problem might be solved by an inter-community organization serving a large territory, furnishing fire protection by contract to the individual communities. Such an organization might be a public body patterned after those now furnishing water or drainage service to territories organized without regard to municipal or even state boundary lines. In many instances contracts have been made whereby a small community receives protection from an adjoining larger community at a fixed annual charge or on the basis of the actual fire fighting work done. In New Jersey a recent report by a state commission appointed to investigate county and municipal taxation and expenditures points out that if the public fire protection of Hudson County were provided by a county fire department instead of by the individual cities, the annual cost might be reduced from $3,718,917 to $2,094,805. These figures do not include fire prevention activities, which are presumably not susceptible to similar savings.

There may be differences of opinion as to the best method of integrating public fire protection, but it cannot be denied that operation of fire department protection in larger units transcending municipal boundaries may, after an intelligent consideration of all the factors in a given situation, prove to be a reasonable and desirable innovation.

* * * * *

The Lie Detector. An example of the resourcefulness and ingenuity demanded of arson investigators is found in the report of a recent case in Indiana. An elderly farmer had a record of five fires in various buildings owned by him. In each case the fire had occurred during a thunderstorm and the cause set down as lightning. These fires had cost the insurance companies in the neighborhood of thirty-six thousand dollars. Mr. George Coogan, an arson investigator for the Indiana State Fire Marshal Department, was assigned to the case. Lightning is not apt to strike five times in the same place and Mr. Coogan felt certain that the old farmer was making a business of fires. He decided to make a final effort to break down the farmer's story and equipped himself with a pair of radio headphones and some wire. He called at the farmer's home and locked himself and the farmer in a room so as to be free from disturbance. He then advised the farmer that he had brought the latest scientific invention to detect crime, clapped the earphones

on his head and placed the wires against the old man's heart. In a solemn voice he told the old man that the apparatus would instantly detect any lie and demanded how the last fire had been set. Trembling, the old man admitted that he had touched a match to the hay mow following a particularly heavy flash of lightning during a storm. He finally confessed that all five fires had been similarly set.

Results of the Boston Fire Survey.

In 1929 the N.F.P.A. Field Service Department made a comprehensive survey of fire conditions in Boston in collaboration with Miller McClintock of the Albert Russel Erskine Bureau of Harvard University. The study was sponsored by a committee appointed by the Mayor and resulted in the presentation of an exhaustive report containing recommendations to the city, showing how the bad fire record of Boston could be corrected.

As an immediate sequence to the issuance of the report, the Fire Commissioner of Boston ordered three hundred copies of the report and distributed them to every officer in the fire department. The officers of the department were advised that questions on the subject matter of the report would be asked in civil service examinations for promotion, which insured a thorough reading of the report by every officer interested in advancement.

The Boston Chamber of Commerce created a strong fire prevention committee. The committee has been most active, and in planning its program has used the report as its guide.

A new administration took office in Boston in January, 1930, and has recognized the valuable data available in this fire waste report. Shortly after taking office, the new Mayor announced that one of the major recommendations in the report—the need for a comprehensive revision of the city building code, was in his opinion of vital importance and an appropriation of $10,000 for revision was secured. Work on the new code is now in process.

Another major recommendation made by our field engineers was for a complete revision of the existing State Fire Marshal Law. A bill containing a complete revision of the State Fire Marshal Law, based on the recommendation of the report, was drafted and presented to the session of the Massachusetts Legislature in 1930 and was adopted and signed by the Governor. The new law clarified the powers and duties of the State Fire Marshal and was welcomed by the fire authorities of Boston and other Massachusetts cities.

One of the matters clearly brought out in the report was the problem of arson in Boston and the need for a more adequate control. Conflict between state and city authorities on investigation of fires had made the arson situation unusually baffling. The State Commissioner of Public Safety, who has primary control of arson work, did not see his way clear to coöperate with

the Boston Fire Department in the matter. Through the efforts of the fire prevention committee of the Boston Chamber of Commerce and others interested, a law specifically giving the City of Boston the right to investigate suspicious fires was introduced in the legislature in 1931 and was adopted.

Following the adoption of this law, the Fire Commissioner of Boston has appointed an arson squad, consisting of six members of the Fire Department. The Police Department has coöperated by assigning three police detectives to work with the firemen, and the City Law Department has assigned a man to assist in the preparation of cases, making a total of ten on the squad.

Fire records have been improved by the adoption by the Fire Department of a comprehensive record blank, which will encourage better investigation of fires and more detailed fire statistics.

The Model Arson Law was recommended for adoption in Massachusetts. Recently a committee of Massachusetts fire chiefs was appointed by the New England Association of Fire Chiefs to work for this law and the State Attorney General has agreed to coöperate in securing its enactment.

The need for revisions of many of the state regulations covering various fire hazards was pointed out in the report. A start has been made by the State Fire Marshal in the revision of the regulations issued by his division for the control of various fire hazards, as authorized by Chapter 148, General Laws. New regulations have been promulgated on dry cleaning, the storage of fuel oil and oil burners, explosives and fireworks.

To assist in the formulation of regulations and to make available to his division the necessary technical information, the State Fire Marshal in November, 1931, appointed an advisory board of prominent local fire prevention authorities, and one meeting of this board has been held. On December, 15, 1931, a new fire marshal succeeded to the office whose policy in this matter is as this is written unknown, but who will presumably continue the board as it was organized on an entirely non-political basis.

Fire prevention work was stressed as a particularly effective means of reducing losses. As a result the inspection force of the Bureau of Fire Prevention has been increased from twenty-four to forty men.

The question of proper training of the personnel of the Fire Department received considerable attention in the report. This was a feature which had been neglected for many years. Under the direction of the new Fire Commissioner a fire college for the officers of the department has been organized as the first step in a general program of training.

The effectiveness of the response of the Fire Department to fires has been improved by the practice of sending box alarm assignments to telephone alarms received during the night, on Sundays and holidays.

The report called attention to the tremendous reserve of fire apparatus which might be concentrated from the more than forty cities and towns in the

Metropolitan area of Boston in case of a big fire in any part of the district. Further development of mutual aid arrangements between the fire departments in the Metropolitan area has been discussed at meetings of chiefs of fire departments of Greater Boston. The above results of the survey indicate substantial progress to date. This has taken place in the face of unfavorable local political conditions, such as the change in city administrations and the appointment of two new men to the office of State Fire Marshal since the publication of the report. The committee originally sponsoring the survey considered itself discharged with the presentation of the report, but the chairman, the president of a large local department store, has continued an active personal interest. Such results as have been accomplished have been due to the interest and coöperation of the Chambers of Commerce of Boston and other cities in the state, the fire problems of which were similar to those of Boston, and the State Fire Chiefs' organization.

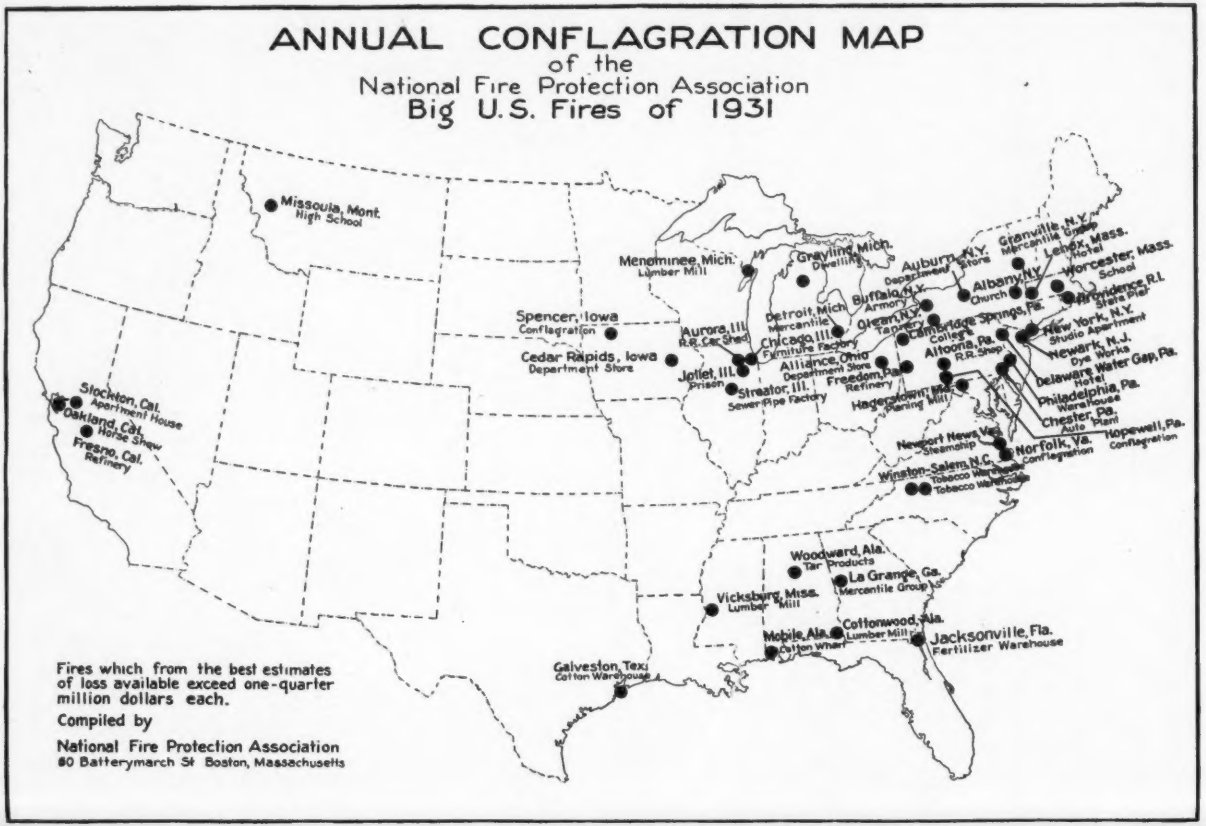
The 1931 U. S. Fire Loss.

The total estimated fire loss in the United States for the year 1931 is $453,500,000. This amount is based on figures compiled by the National Board of Fire Underwriters for the eleven months ended November 30, 1931, with an estimate for December based upon loss experiences for the same month in previous years adjusted for the trend of losses of the current year. The total estimate is approximately ten million dollars less than the 1930 preliminary loss estimate, a reduction of 24 per cent.

Comparative Monthly Loss Estimates, 1929, 1930 and 1931.

	1929	1930	1931
January	$44,713,825	$42,344,035	$44,090,449
February	41,520,290	43,206,940	41,776,051
March	41,277,814	42,964,392	44,074,362
April	36,845,795	43,550,996	41,423,764
May	32,129,408	38,415,142	37,835,273
June	33,605,663	31,818,266	33,368,378
July	31,985,493	34,847,750	33,024,594
August	30,446,893	36,043,679	31,917,630
September	29,249,355	35,230,456	33,202,986
October	31,652,385	36,838,614	35,501,530
November	29,061,869	35,682,577	35,287,641
Total 11 months	$382,488,790	$420,942,847	$411,502,658
December	39,726,388	42,669,915	42,000,000*
Total 12 months	$422,215,128	$463,612,762	$453,502,658
Adjusted loss figures (Released later in year.)	$459,445,778	$499,739,132	

*December figure is taken as an average of the losses for the previous years adjusted for the 1931 trend.


ANNUAL CONFLAGRATION MAP
of the
National Fire Protection Association
Big U.S. Fires of 1931
Missoula, Mont. High School
Menominee, Mich. Lumber Mill
Grayling, Mich. Dwelling
Auburn, N.Y. Department Store
Granville, N.Y. Mercantile Group
Lehex, Mass. Hotel
Worcester, Mass. School
Albany, N.Y. Church
Providence, R.I. State Pier
Spencer, Iowa Conflagration
Detroit, Mich. Mercantile
Buffalo, N.Y. Armory
Olean, N.Y. Tannery
Cambridge Springs, Pa. College
New York, N.Y. Studio Apartment
Aurora, Ill. R.R. Car Shed
Chicago, Ill. Furniture Factory
Cedar Rapids, Iowa Department Store
Alliance, Ohio Department Store
Freedom, Pa. Refinery
Altoona, Pa. R.R. Shop
Newark, N.J. Dye Works
Joliet, Ill. Prison
Streator, Ill. Sewer-Pipe Factory
Hagerstown, Md. Planing Mill
Delaware Water Gap, Pa. Hotel
Philadelphia, Pa. Warehouse
Chester, Pa. Auto Plant
Hopewell, Pa. Conflagration
Stockton, Cal. Apartment House
Oakland, Cal. Horse Show
Fresno, Cal. Refinery
Newport News, Va. Steamship
Norfolk, Va. Conflagration
Winston-Salem, N.C. Tobacco Warehouse
Woodward, Ala. Tar Products
La Grange, Ga. Mercantile Group
Vicksburg, Miss. Lumber Mill
Cottonwood, Ala. Lumber Mill
Mobile, Ala. Cotton Wharf
Jacksonville, Fla. Fertilizer Warehouse
Galveston, Texas Cotton Warehouse
Fires which from the best estimates of loss available exceed one-quarter million dollars each.
Compiled by
National Fire Protection Association
60 Batterymarch St Boston, Massachusetts

Aggregate Loss for Sixteen Years Exceeds Seven Billion Dollars.

The 1931 fire loss brings the total fire waste of the United States during the past fifteen years up to the stupendous sum of $7,228,228,447, an annual average of approximately 450 million dollars. Those losses, however, should be considered in relation to present-day burning ratios, which in turn are based upon steadily increasing property values exposed to fire. For example, the fire loss of $258,377,952 in 1916 may very possibly have resulted in as high a burning ratio to the aggregate value of all property in that year as the $453,000,000 loss of 1931 is to present valuations. The following table gives the annual fire loss record by years since 1916.

Annual Fire Losses in the United States from 1916 to 1931 inclusive.

1916	$258,377,952	1925	$559,418,184
1917	289,535,050	1926	561,980,751
1918	353,878,876	1927	472,933,969
1919	320,540,399	1928	464,607,102
1920	447,886,677	1929	459,445,778
1921	495,406,012	1930	499,739,132
1922	506,541,001	1931 (Est.)	453,502,658
1923	535,372,782		
1924	549,062,124	Total	$7,228,228,447

Large Loss Fires, 1931.

During the year 1931 there were 43 fires involving a loss estimated at $250,000 or more as compared with 68 such fires during the previous year. Every section of the country showed a decrease in large loss fires, except the Southern states, where the number increased from seven in 1930 to eleven in 1931, and in the Rocky Mountain area which reported one fire in 1931 and none in 1930. The location of these fires is shown on the accompanying map.

Of the total large loss fires in 1931, but three could strictly be regarded as conflagrations. The first of these occurred on June 7 at Norfolk, Virginia, and involved about sixty buildings adjacent to the waterfront. The total loss was estimated at approximately $1,000,000. A detailed account of the fire was published in the QUARTERLY, July 1931, Vol. 25, No. 1. The second fire of conflagration proportions occurred on June 27 at Spencer, Iowa. This fire had its origin in a drug store when a boy dropped a lighted sparkler in a display of fireworks. Twenty-five buildings were destroyed and ten others were damaged with a total property loss estimated at $800,000. On November 26 a conflagration at Hopewell, Pa., destroyed thirty-one buildings with a loss of $250,000. There was no local fire protection and, owing to the blocking of a bridge by the flames, fire apparatus from adjacent towns had to make a fourteen mile detour to reach the fire.

Two other fires, characterized as "group" fires, involved several buildings and presented all the elements of incipient conflagrations. These fires and

their losses were as follows:

January 11, 1931, LaGrange, Ga., 4 buildings	$250,000
March 25, 1931, Granville, N. Y., 7 buildings	350,000

To these might be added the Buffalo, N. Y., Armory fire of May 6, flying brands from which caused more than seventy-five roof fires and resulted in the destruction of a church. (See QUARTERLY, July 1931, Vol. 25, No. 1.)

There were a number of fires involving single buildings or property where the reported loss was more than $500,000. A tabulation of these losses follows:

January 16, 1931, Philadelphia, Pa., leather warehouse	$578,000
January 20, 1931, Cambridge Springs, Pa., college building	625,000
February 25, 1931, Providence, R. I., state pier	750,000
April 2, 1931, Vicksburg, Miss., lumber mill	500,000
April 13, 1931, Menominee, Mich., lumber mill	1,000,000
April 29, 1931, Winston-Salem, N. C., tobacco warehouse	660,000
May 6, 1931, Buffalo, N. Y., Armory	5,000,000
December 3, 1931 Jacksonville, Fla., fertilizer warehouse	575,000
December 20, 1931, Newport News, Va., ship under construction	2,000,000
December 27, 1931, Altoona, Pa., railway shops	1,500,000

The occupancies involved were about equally divided between mercantile establishments (wholesale and retail), industrial plants and miscellaneous occupancies.

Occupancy	No. of Fires		Estimated Loss
Mercantile Establishments		12	$4,617,000
Wholesale	6	$2,904,000	
Retail	6	1,713,000	
Industrial Plants		12	4,628,000
Miscellaneous Occupancies		16	13,843,000
Armory	1	$5,000,000	
Ship under construction	1	2,000,000	
Railway shops	2	1,750,000	
Apartment buildings	2	750,000	
Piers and wharves	1	750,000	
Resort hotels	2	718,000	
College building	1	625,000	
Horse show	1	500,000	
High school	1	500,000	
School under construction	1	400,000	
Church	1	300,000	
Penitentiary	1	300,000	
Dwelling	1	250,000	
Conflagrations		3	2,300,000
Total		43	$25,388,000

To determine the factors that have been responsible for making these forty-three fires large loss fires an analysis has been made of the reports of these fires filed with the N.F.P.A. Department of Fire Record. Not all large losses can be attributed to a single factor and in some instances four or more factors have been equally responsible for the rapid spread of, and consequent large damage by the fire. Such a case was the fire which destroyed a large

frame tannery at Olean, N. Y. It is reported that the reasons for this large loss were: (1) delayed alarm, (2) failure of private fire protection, (3) lack of protection against exposure, (4) inadequate water supply and (5) lack of pumpers.

The factors indicated by the reports as being responsible for the large losses of 1931 are summarized below. It is obvious from the totals that in most instances more than a single factor was involved.

Reason for Large Loss.

	No. of Fires
Highly combustible contents or excessive amounts of burnable materials	18
Delay in discovery of fire	18
Inferior construction	18
Ineffective fire fighting	14
Failure of private fire protection — 7	
Fire department delayed in getting to work — 5	
Misuse of private mains — 1	
Inefficient fire fighting — 1	
Previous fire rekindled (fire dept. not called to first fire) — 1	
Delayed alarm	8
Lack of adequate private or public fire protection	9
Inadequate water supplies	7
Unfavorable weather conditions	5
Lack of protection against exposure	3
Large quantities of flammable liquids	2

The factor most frequently noted as responsible for large loss fires was "highly combustible contents or excessive amounts of burnable materials." When large stocks of highly combustible material are once well involved the resultant fire is difficult to control and a large loss is almost inevitable. Characteristic fires of this sort were the two tobacco warehouse fires in Winston-Salem, N. C., on April 29 and May 1, the first resulting in a loss of $660,000 and the second more than $400,000. The Moody Cotton Warehouse fire in Galveston, Texas, on Oct. 11, involving a loss of $350,000, was a similar fire.

Another principal factor was "delay in discovery of fire." In consideration of this factor an analysis of the day of the week and time of day when these fires occurred is interesting, particularly in relation to the factors which were in part responsible for the fact that these fires became large loss fires. It is significant that of the 43 large loss fires, 31 occurred in the period from 6 P.M. to 6 A.M., four were on Sundays or holidays and only 8 occurred during periods of normal activity.

Inferior construction, as might be expected, played its part in making possible the rapid spread of fire throughout the building. Typical examples of fires where inferior construction played a major part were the Lincoln Square Arcade Building fire in New York City on January 29 (QUARTERLY, April 1931, Vol. 24, No. 4), the Buffalo Armory fire and the recent million dollar fire in the Pennsylvania Railroad shops at Altoona, Pa.

Delayed alarms were also an important factor in the large loss fires of 1931. A typical instance occurred only a few weeks ago in Auburn, N. Y.,

when a loss of well over $250,000 was occasioned by a fire in a department store. The fire occurred during Christmas week at noontime. When the fire department arrived in response to a telephone call they found the cellar and sub-cellar badly involved. Employees had been fighting the fire for some time, and when they decided to send in an alarm they found the store telephone wire burned out and went into the store next door to transmit their call.

The other factors listed in the foregoing table are self-explanatory and might have been guarded against by adequate preparation and forethought.

For the most part these large loss fires occurred within the jurisdiction of municipal fire departments. The following tables indicate in a general way how they were handled.

	No. of Fires
City fire department alone	21
City fire department and outside aid	11
City fire department and private fire brigade	7
City fire department, outside aid and private brigade	1
Private fire brigade alone	1
Outside fire departments	1
No fire protection	1
Total	43

The fire where a private fire brigade alone was employed was in an oil refinery located some distance from the nearest community. The fire where no protection was used, destroyed a large country mansion located beyond municipal protection. A rural pumper responded to a call for help, but the truck was disabled before reaching the fire.

Large Loss Fires in Canada.

Reports of ten Canadian fires involving individual losses of $250,000 or over have been received by the N.F.P.A. Department of Fire Record. These fires caused an aggregate loss of $7,632,700, of which $5,000,000 was chargeable to a single fire, the Canadian Pacific Railway wharves and pier sheds at St. John, N. B., on June 22 (QUARTERLY, July 1931, Vol. 25, No. 1). A summary of the large loss fires is as follows:

Date	City	Occupancy	Estimated Loss
Jan. 25, 1931,	Winnipeg, Man.,	Stores and Offices	$332,700
Jan. 25, 1931,	St. Valier, P. Q.,	Church	250,000
Jan. 29, 1931,	Montreal, P. Q.,	Church	250,000
Feb. 8, 1931,	Ottawa, Ont.,	Church	300,000
Feb. 1931,	Montmorency Falls, P. Q.,	Church	250,000
Apr. 24, 1931,	Montreal, P. Q.,	Flour mill	350,000
June 22, 1931,	St. John, N. B.,	Piers and wharves	5,000,000
Sept. 30, 1931,	Foss Mills, Ont.,	Lumber yard	400,000
Dec. 13, 1931,	Montreal, P. Q.,	Mercantiles	250,000
Dec. 15, 1931,	Charlottetown, P. E. I.,	Institution	300,000
Total			$7,682,700

N. F. P. A. Field Service Map.

A study of these maps will indicate the surprisingly favorable location of the N.F.P.A. headquarters in Boston for field work among cities and the equitable spread of field activities thus far. Cities not yet visited are largely those with favorable fire records.

U. S. Cities Over 20,000 Population.

U. S. Cities Visited by N.F.P.A. Field Service.

The Harvard Forest Fire Study.

A study of forest fire experience with particular reference to the possibilities of forest fire insurance has been completed during the past year as a research project of Harvard University Forest, conducted by C. C. Averill and L. M. Frost. The following summary covers some of its interesting features; the complete report is a comprehensive document which cannot be covered in detail in this review.

The administration of commercial forests on a permanent yield basis, which is the ultimate objective of forest and conservation authorities who have been pointing out for many years the wastefulness of past and present forest exploitation methods, has been greatly handicapped by the forest fire hazard. Despite all reasonable precautions that can be taken, the hazard is still present and there is always the possibility that a disastrous forest fire may wipe out the entire investment in any forest project. Such uncertainties, it is felt by the sponsors of this study, constitute one of the primary hindrances to the administration of forest tracts on a sustained yield basis with resultant benefits to the owners and to the general public. Forest fire insurance, which would assure safety of investment in forest projects, has been available and quite widely applied in several European countries, but thus far is in the United States only in an experimental stage. The authors indicate that while there are a few insurance companies that write forest fire insurance, such business is not being actively solicited and the rates are considered prohibitory by timberland owners.

The Harvard Forest study shows definitely the forest fire losses in a representative area in relation to the total burnable values, and evaluates the various factors of hazard and fire protection for the purpose of establishing a method for estimating for any given tract the probable loss experience over a period of years. The present study has been necessarily limited to the State of Massachusetts and only certain forest tracts on which complete data are available have been intensively studied. The results are not offered as necessarily conclusive in their numerical values, but the study does present a method of treatment, which if applied over a large territory on a broad basis, should establish a definite method for evaluating forest fire losses that would be of very great benefit not only in respect to fire insurance on forest property, but in various other ways.

The authors point out that forest fire losses are currently reported in terms of acres burned or dollars of loss without reference to the total commercial value of the forest lands. Many forest fires destroy timber areas which have very low commercial value and while from the public viewpoint

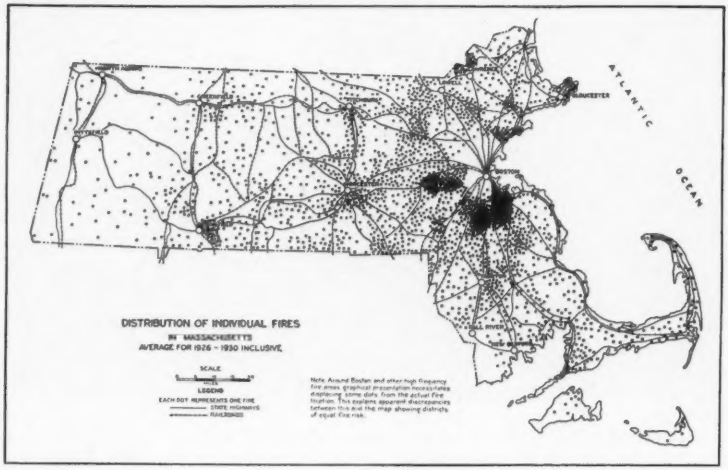
Blackington.

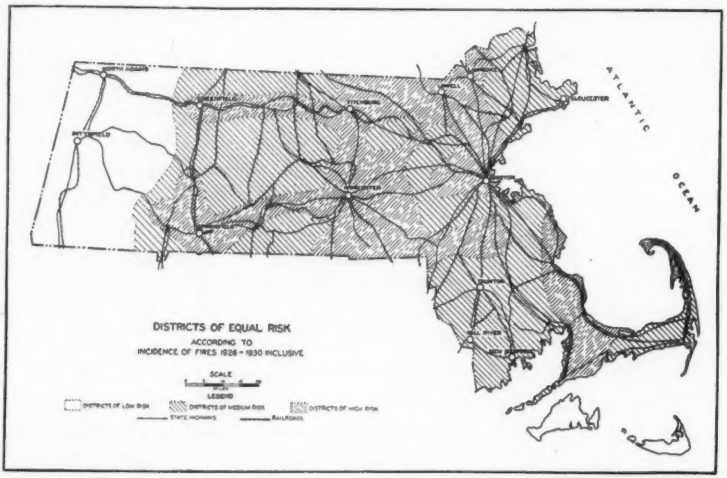
Open grasslands and cut over lands under fifteen years of age have the highest combustibility rating on the proposed grading schedule for forest fire risk. Fires of this character involve small damage while confined to open grassland, but are a dangerous menace to adjoining stands of valuable timber.

such fires are most undesirable in destroying forest cover, interfering with future productiveness of the land, destroying water shed protection, etc., nevertheless in relation to the commercial value of the timber the loss has been relatively small.

In the present study six typical forest areas embracing a total of approximately eight thousand acres were selected for detailed study. These tracts had been under the same ownership and consecutive management for fifteen years or more. All the fires which had occurred on these properties during a fifteen-year period were carefully analyzed and detailed estimates made of the total value of the standing timber in each year. It was found that the average loss per year per one hundred dollars of value of standing timber was 5.4 cents. The average fire loss per acre per year was 1.8 cents. The properties studied varied in physical characteristics, in degree of fire hazard and in the extent of the fire protection available. In each case an analysis was made of the character of the hazard and after careful consideration of the factors contributing to the fire risk a proposed grading schedule was devised, which is designed for determining the relative probability of fire loss on forest properties in general. This schedule gives an interesting analysis of the various elements in the forest fire problem and is reproduced herewith.

This grading schedule for forest fire risks takes into account the differences in combustibility of different types of forest cover and the various elements of fire hazard and fire protection. The numerical figures used, of course, are based on judgment and would be subject to change as a result of further experience, but the method would seem applicable under a wide





Harvard University Press.

variety of conditions. It should be noted that there are other factors which cannot be definitely provided for in such a schedule. The attitude of the permanent population towards the local forest area is a matter of primary importance. In a territory where the livelihood of a large proportion of the inhabitants comes from logging or wood-using industries a better experience may be expected than in an area where the wood lands play no part in the livelihood of the inhabitants. General weather conditions, though not mentioned specifically in the schedule, are, of course, of primary importance and

Blackington.

Softwood stands under thirty years of age rank next to open grasslands on the combustibility rating schedule.

it is understood that in any national application of such a schedule the results would have to be weighted for weather conditions and other territorial influences. The variation in the experience of the forest fire risks, in accordance with the character of population, weather conditions, etc., is shown for the State of Massachusetts by the accompanying illustrations reproduced from the original report.

The conclusion of the authors is that "the present study disproves for this region at least the conviction generally held by foresters and underwriters that timberlands in the aggregate are subject to unusually high loss costs and to such high fire risks that insurance is impossible."

A Grading Schedule for Forest Fire Risk.

Combustibility. (Average 50 points.)	Points +	Points —
1. Swamps which are wet the year round		10
2. Open and poorly stocked stands of softwoods fifty years old and up	10	
3. Hardwood stands above brush size. Open softwood stands thirty to fifty years old	50	
4. Softwood stands under thirty years of age	80	
5. Cut-over lands under fifteen years of age. Open grasslands or grasslands on which plantations have recently been established	100	
Exposure Hazard. (Average 100 points.)		
1. Centers of population:		
Within a radius of 25 miles of cities of 150,000 or more	15	
Within a radius of 15 miles of cities of 20,000 to 150,000	10	
Within a radius of 2 miles of cities of 1000 to 20,000	5	

International.

Near-by centers of population, railroads, highways and other occupancy in or near a wooded area increase the forest fire hazard, according to the grading schedule.

	+	—
2. Railroads (coal-burning)		
Adjacent or within 1/10 mile of property	25–100	
One-tenth to one-half mile from property	10–50	
One-half to one mile from property	0–20	
3. Highways		
State highways and paved town roads:		
Adjacent to property	15–45	
Not adjacent but within ½ mile	5–15	
One-half to 2 miles from property	2–6	
Graveled road adjacent to or within 1/10 mile of property	5–15	
Dirt road within ½ mile of property		5
4. Occupancy		
Fishable stream on or within ¼ mile of property	15–45	
Hunting permissible	5	
Camp sites on or adjacent to property	4–12	
Logging operations going on at present on or adjacent to property	5	
Construction work going on at present on or adjacent to property	3–9	
Dwellings adjacent to or within ½ mile of property	5–15	
Resident who is responsible for fire suppression on property during fire seasons		10
Rubbish piles or dump within ½ mile of property	0–20	
Any other use not listed that may increase the fire risk	0–20	

The range of points for any one exposure hazard is to allow for variation in the marginal inflammability adjacent to the exposure.

Protection. (Average credit 50 points.)

1. State protection		
All parts of property visible from a fire tower		10
Within a radius of 15 miles of state equipment		5
2. Town protection		
Power pump, pump cans, and other hand tools		35
Pump cans and hand tools only		20
Patrol during dry seasons		5

	+	—
3. Private protection		
Power pump, pump cans, and other hand tools		50
Pump cans and hand tools only		25
Patrol during dry seasons		10
Power pumps usable only on the following percentage of property due to lack of water:		
75 to 90 per cent	5	
50 to 75 per cent	15	
25 to 50 per cent	20	
Less than 25 per cent	25	
Property posted		3
All adjacent property posted		5

Average points for entire schedule, 150 plus, 50 credit, total 100. Grading may vary from zero for no hazard to 300 points for extremely high hazard. This schedule is intended for application in areas of uniform weather conditions; it would be subject to appropriate weighting for variation in weather conditions.

Spontaneous Heating and Ignition.

By Harold H. Brown and Norman J. Thompson,
N.F.P.A. Committee on Spontaneous Heating and Ignition.

The annual fire losses due to spontaneous ignition are estimated at between $45,000,000 and $50,000,000. There are almost no data available upon which to base an estimate of losses which are due to spontaneous heating where ignition has not resulted, but spontaneous heating which results in the rotting or aging of many agricultural and industrial products without leading to fire undoubtedly represents an enormous economic loss.

The existence of spontaneous ignition or combustion was recognized in very early times and was referred to in literature by early Greek and Latin writers. For such an old and widely recognized natural phenomenon it is surprising that sufficient thought and study have not been given to determine the fundamental processes taking place in the heating and ignition of various materials. A number of theories have been advanced, most of them based upon some experimental evidence, but no one of them sufficient to explain all conditions which have been noted. One of the early theories was based upon the fact that friction developed heat. This could hardly explain the heating of materials which had been long in storage and had not been moved. Another theory was that of the accumulation of vital heat, it being supposed that the warmth created by living tissues such as those of freshly cut grass, would continue to accumulate if held in a confined space and would finally raise the temperature to the point of ignition.

It has been found that a considerable amount of heat is developed in the rapid absorption of gases by finely divided and porous materials. Finely divided carbon, iron and many other substances will absorb oxygen very

The authors, chairman and member of the N.F.P.A. Committee on Spontaneous Heating and Ignition, have prepared the article at the direction of the committee and in order to acquaint N.F.P.A. members and others interested with the program of the committee.

readily with rapidly mounting temperatures. Experiments have been carried out indicating that the presence of these materials will greatly hasten spontaneous ignition. These experiments have led to two separate theories, one being known as the pyrophoric carbon theory and the other the pyrophoric iron theory. While these theories have a reasonable application in some cases, they do not give any satisfactory explanation for other cases of spontaneous ignition where finely divided substances may not have been present.

A number of other theories have been advanced suggesting that the spontaneous ignition of vegetable products is caused by heat generated by the action of micro-organisms, but in every case these theories have always failed to explain what takes place after temperatures have been reached that will kill the known micro-organism. Dr. C. A. Browne, Chief of the Chemical and Technological Division of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, has recently brought out a theory to explain the development of heat beyond the temperature that might be created in the fermentation process. His theory is based upon the micro-organism developing unsaturated, highly unstable, intermediate fermentation products upon the surfaces of the porous cellular material. These highly unstable compounds readily oxidize with the generation of increasing quantities of heat that first lead to the destruction of the organism and eventually to the ignition of the vegetable matter. One of the best known and rather common illustrations of spontaneous ignition is that of rags or cotton waste saturated with oxidizable oil, such as linseed oil. This is so well known that most people are careful not to leave such oil-soaked rags where there would be any danger of fire, if spontaneous heating should occur. Such cases of spontaneous ignition are commonly attributed to the very rapid oxidation of thin films of oil spread out over the surface of the fibers. Many oils oxidize readily, but the rate of oxidation is controlled very largely by the original temperature, the amount of surface exposed and the effectiveness of the insulation.

The opinion is often held that a material should not be classified as subject to spontaneous ignition that will not heat at ordinary room temperatures. However, heating in some substances may occur very slowly at room temperature, while it would increase very rapidly at slightly elevated temperatures. Very few micro-organisms will become active at low temperatures, but most of them become very active at ordinary room temperatures or slightly above. The action of these micro-organisms may be sufficient to raise the temperature of the products to a point where rapid oxidation may occur, leading to higher temperatures and subsequently to actual ignition. Consequently, the temperatures to which materials may be subjected in storage or in transit, as well as the characteristics of the materials, should be given careful consideration.

From the standpoint of fire prevention we are primarily interested in that spontaneous heating which results in ignition and fire, but from an economic standpoint, that spontaneous heating which causes deterioration and decay of all kinds of vegetable matter is undoubtedly by far the more important. The loss of farm property, due to spontaneous ignition of hay, is estimated to be in excess of $20,000,000 annually, but the economic loss due to spontaneous heating, causing loss in weight, grade and nutritive value of the hay is several times this amount. As a result of a careful investigation it has been conservatively estimated that at least one-tenth of the harvested hay crop of the United States, having an annual value of about thirteen hundred million dollars ($1,300,000,000) is lost through spontaneous heating. This indicates that the economic loss from the spontaneous heating of hay which does not reach the point of ignition is fully six times that destroyed by fire.

More attention seems to have been given to the study of spontaneous heating and ignition of hay than of any other farm product. But even a casual consideration of losses due to the spontaneous heating of other farm products, such as wheat, corn, oats, fruit and vegetables, would most assuredly lead to a conclusion that the losses in any or all of these products would be proportionally as great as are the losses in the hay crop. One has but to visit the grain elevators or the fruit or vegetable markets to get an idea of the stupendous economic losses sustained by these products between the time of harvesting and consumption.

The causes and processes of spontaneous heating are the same whether they lead to fires or only to decay. These immense economic losses, together with the large number of fires occurring in storage of farm products, led to the calling of a conference on the subject in Washington in 1929 by the National Fire Protection Association in coöperation with the United States Departments of Agriculture and Commerce. As a result of this conference the N.F.P.A. Committee on Spontaneous Heating and Ignition was organized.

The committee is attempting to correlate all information that is available on this subject and requests the coöperation of all those desiring to undertake research in this field, and those who have information regarding tests which have been made or regarding fires which have been known to be caused by spontaneous combustion. The committee is particularly desirous of coöperating with educational institutions and industrial organizations that are willing to undertake research studies, which will contribute to the knowledge of spontaneous heating phenomena and which subsequently may be the basis of a partial solution at least of this vexing problem.

Specific lines of research should be conducted that would apply to farm products, such as hay, grain, commercial fertilizers, cattle, feed, etc., as well as to the raw and finished materials of industry, such as jute, hemp, cotton, hides and leather, raw and vulcanized rubber, wood, paper and other wood

products, paints and other decorative or protective coatings, charcoal and other finely divided carbons, vegetable and animal oils, etc.

With particular reference to farm products, research studies which have been suggested are:

1. Studies of bacteriological strain, recurrence and distribution of important types, and conditions necessary for their growth. Determinations of temperature where the action of various bacteria ceases; and studies of the products of bacterial action.

2. The making of mineral analyses of samples of hay and other agricultural products; determining the organic composition of samples; and the study of products of heating, including carbonized and gaseous products, such as would be obtained in destructive and steam distillation.

3. Study of materials and methods of application which can be used to retard bacterial action in order to prevent the rotting as well as the heating of hay and other farm products.

4. Studies of the effect of degree of curing of hay, harvesting, the relation of farm machinery to heating, and the effect of ventilation or methods of aeration of hay in mows,—all with relation to the final condition of the hay.

5. Development of methods or apparatus for satisfactory laboratory procedure in determining heat evolution at extremely small rates, or the rate of oxidation or rate of oxygen absorption.

6. Determination of exposed surface area, effect of amount of exposed surface on rate of heating, effect of density or compact packaging on circulation or infiltration of air in influencing spontaneous heating in industrial products.

7. Tests of the oxygen consuming power of fresh and fermented products of vegetable origin, together with concurrent chemical and bacteriological tests during heating or deterioration. Simultaneous tests to observe the action of suitable sterilizing agents in suppressing bacterial action.

8. Development and study of methods of stopping spontaneous heating that has once started. Under what conditions may the addition of chemicals or the displacement of air by inert gases, such as nitrogen or carbon dioxide, be effective?

9. In all studies or tests, full data should be given as to the physical or chemical conditions of the product or sample, such as age, density, particle size or fiber diameter, moisture content, and any other pertinent items.

NOTE: Any information on this whole broad subject of spontaneous heating and ignition and any requests for coöperation on research problems should be submitted to the National Fire Protection Association at 60 Batterymarch St., Boston, Mass., or to Mr. H. E. Roethe, Secretary, Committee on Spontaneous Heating and Ignition, Bureau of Chemistry and Soils, Washington, or to Dr. H. H. Brown, Chairman, Committee on Spontaneous Heating and Ignition, 475 Fifth Ave., New York.

The Fire Service of Düsseldorf, Germany.

By Fire Chief B. Petersen.

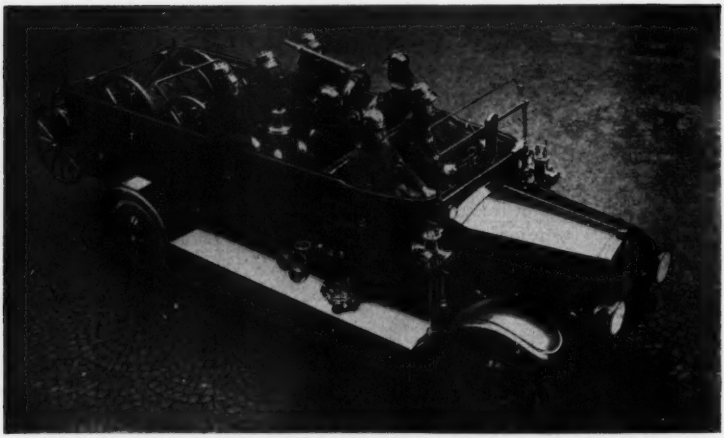
Düsseldorf, a city of 480,000 population, is one of the chief industrial and commercial centers of western Germany. It is situated on the river Rhein along which it extends for a distance of about 16 miles. The city covers an area of about 61 square miles, of which one-fourth is covered by buildings.

Fire Brigade.

The city is divided into six fire districts, each of which is provided with a fire station of the professional fire brigade. The personnel of the brigade consists of a fire chief, five fire brigade engineers, five fire wardens and 210 firemen. In addition to these there is also a technical staff consisting of thirteen men assigned to the fire alarm branch and four technical assistants assigned to the fire prevention division and the administration office. The fire department also has charge of the ambulance service and the city disinfecting plant. These two divisions have their own special staff.

The regulation minimum crew of a fire fighting unit or section, consisting of a motor fire engine and aerial turntable ladder, is one section chief and

Düsseldorf Fire Brigade Headquarters. This station is one of six which serves this city of 480,000 people. Each station is expected to handle all but the most serious fires in its district. Note drill tower at extreme left of picture.



Squad and hose car, Düsseldorf Fire Brigade. Hose is carried on reels which are run from the hydrant or pumper to the fire by hand. Note portable hydrant at either side of machine at the front, also modern deck pipe.

sixteen men. In consequence of economy measures this regulation force at the present time is not at its full strength. Four fire stations are provided with two fire fighting units each, one suburban station has a motor fire engine and the fire station of the Port is provided with one motor fire engine, a motor driven fireboat and a steamboat with a fire pump.

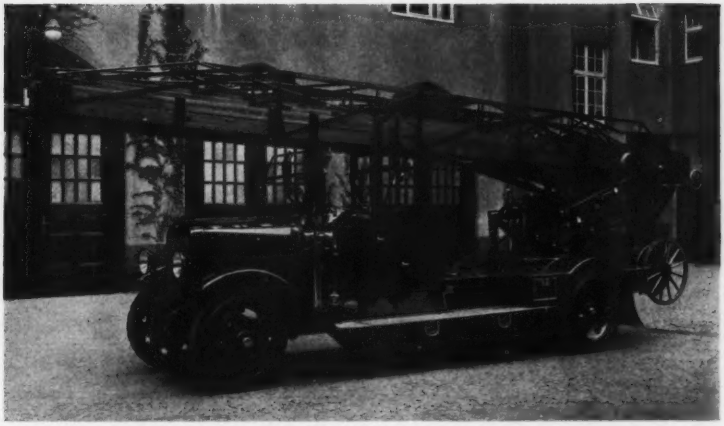
In contrast to the practice in America where preference is given to many, but smaller, stations it is customary in Germany to have less fire stations, but better equipped ones from the standpoint of the number of men and pieces of equipment. Each fire station is expected to be in a position to put out the average size fire independently in its own district and to handle up to eight hose lines.

The principal mobile equipment of the department, which is entirely motorized and distributed among the six fire stations, is as follows:

10 Motor fire engines (pumpers)	2 Steam fire engines
1 Turbine fire engine	3 Hose and squad cars
6 Motor turn-table (aerial) ladders	5 Rescue cars
2 Fireboats (located at the Port)	

In addition to this equipment are a special car carrying foam equipment, other special chemical apparatus and a smoke ejector; an emergency car for first aid in event of accidents due to breakage of gas or water mains; a sapper's car; five motorcycles for inspection work; and sundry other vehicles for the use of the fire alarm division and for the transportation of materials.

The motor fire engines have 70 h. p. motors and centrifugal pumps of 530 gallons per minute capacity. A 90-gallon booster tank is provided for use at small fires. Each pumper carries approximately 1500 feet of hose together



Typical Magirus turntable ladder, Düsseldorf Fire Brigade. Equipment of this type is found in most European cities.

with first aid chemical extinguishers, a 40-foot folding extension ladder, a life net, a life line, two oxygen helmets, gas masks, pulmotor, first aid kit and a complete assortment of miscellaneous tools. Eight men in addition to the driver and section-chief accompany the pumper.

The mechanical turntable ladders (Magirus type) have a length of 98 feet when fully extended. Foam generating equipment and powder are provided at each section. The stock of hose of the brigade amounts to 78,720 feet, of which one-third is on the apparatus, one-third in reserve at the stations and one-third in reserve at the central hose storage room.

The firemen are on duty twenty-four hours and then have twenty-four hours off. While on duty the crew of each fire station is occupied in the workshops which are provided in the station. In these workshops is performed all the work required for the individual station. All necessary construction work is done, tools are made and kept in good order and the uniforms are also made by the men themselves. The firemen are required on their time off to report to their fire station in event of a big fire. They are also required when off duty to make safety inspections of theatres and other places of public assembly.

There are 5700 fire hydrants throughout the city, of which 400 are standpipe outlets in the upper stories of buildings. The average water pressure is 68 pounds. Six hundred fire alarm stations are connected to the fire alarm system. These stations, or boxes, are distinguished by a green blinker light. A number of buildings are equipped with "rate of rise" fire alarm systems.

Each fire station has its own telegraph station in which the alarms from its own district are received and by means of which the crew are immediately

The Düsseldorf rescue squad is equipped to handle all sorts of rescue work. Several types of gas and smoke masks and oxygen helmets are carried, together with inhalators and a stretcher for emergency cases. For river accidents the squad is provided with life preservers, oars and a collapsible boat.

warned and called out. All such alarms, however, are also transmitted to the Central Fire Station, so that headquarters is immediately informed whenever a sub-station turns out. Fire alarms may also be transmitted by telephone by calling the number 02. This number applies in all German cities for summoning the fire brigade. (The emergency call for the police is 01.) All telephone alarms are received at the Central Fire Station and from here the proper sub-station is notified by an automatic tele-signaling installation.

Intercourse between fire stations is handled by tele-writing machines. Not only are all fire alarms automatically time stamped on arrival, but the time of all incoming telephone conversations is automatically recorded and the conversations noted on a so-called "Dailygraph," which can later be reproduced if desired.

The transmission of alarms to the apparatus room of the fire stations is done by transmitters which are automatically connected when the alarm is received. In the apparatus room the designation of the street and, in the case of a telephone alarm, the location of the fire appears on a screen in writing rather than on a tape in numbers or in Morse characters.

Fires and Fire Prevention Work.

While the fire brigade was called out more than 1000 times during the year 1930, the number of large fires amounted to but 25. The number of large fires has materially decreased in recent years in spite of an increase in the number of alarms. This may be attributed to the modern equipment and intensive training of the brigade making for more efficient operation, and to the activities in fire prevention.

Fire prevention work is carried out by the fire brigade engineers to whom four assistants are assigned. For this purpose the city is divided into fire prevention districts. Current inspection of about 400 buildings involving considerable fire hazards is carried out by the so-called Safety Council. In the Safety Council there are represented, aside from the fire department, the building inspection department, the police chief, the city electrical department and, in certain instances, the industrial inspection office. For the purposes of inspection by the Safety Council the properties involving a greater fire hazard are subdivided into three classes.

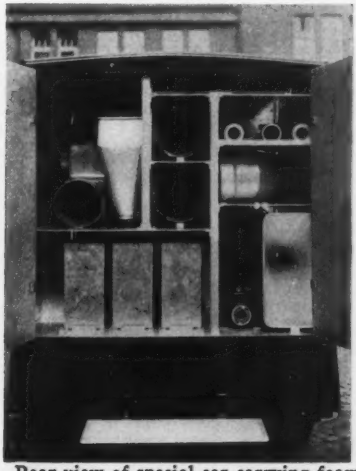
Class 1 comprises department stores, the biggest commercial houses, film laboratories, motion picture film exchanges, theatres and moving picture houses. They are inspected twice per year.

Class 2 comprises fairly large commercial houses, warehouses, factories and plants in which flammable materials are employed. They are inspected once a year.

Class 3 comprises places of public assembly, churches and garages. They are inspected every two years.

The fire department is consulted by the building inspection department concerning all proposed building constructions where fire hazards exist or where a large personnel is employed or through which there is a lot of traffic. The recommendations of the fire department are communicated to the building contractor through the building inspection department, but the carrying out of the recommendations is controlled by the fire department. During the year 1930 the fire department issued and effected 1290 written opinions and inspections of a fire-police character.

Interior of rescue wagon, showing some of equipment. Note smoke and gas masks, inhalators, rope, lights and life preserver for marine rescues.



Rear view of special car carrying foam generator with cans of powder, and smoke extractor with piping.

Sacramento Cleans House.

Every city is faced with the problem of the old dilapidated building. It has long been recognized that buildings that have become unsafe and in danger of collapse may be ordered razed by city building authorities as a protection to public safety, but the idea that the old frame building presenting a serious fire menace to the community should and could be condemned and removed has been slower to gain acceptance. With the growth in recent years of fire prevention activities, particularly in fire departments, interest in the problem of removing hazardous old buildings has increased.

Among the several cities along the Pacific Coast that is successfully meeting the problem is Sacramento, Cal. For the past three years this city has been carrying on a quiet but effective campaign to rid itself of dilapidated structures. The instigators of this campaign are Fire Chief M. J. Dunphy (Member N.F.P.A.) and Assistant Building Inspector B. H. Covell. The accompanying illustration, the original of which hangs in Chief Dunphy's office at fire department headquarters, shows an assembly of photographs of one hundred and fifty-six buildings that have been razed through the efforts of these energetic clean-up men.

Sacramento is one of the oldest cities in California and in the years past has accumulated a considerable number of old buildings which have been permitted to go to rack and ruin until they have become, not only eye sores, but serious fire hazards and a menace to public safety. In 1929, 105 of these dilapidated structures were removed, in 1930 there were razed an additional 164, and in 1931 147 buildings disappeared.

It is interesting to note that these buildings were not removed by the ordinary procedure of condemnation, but through personal interviews with the property owners. Chief Dunphy and Inspector Covell called on the owners of the buildings in each case and, after pointing out the fire hazards and the potential danger to life and limb, reached an agreement with them to have the structures razed. The work of ridding the city of these hazards will continue until all have been razed.

Water Consumption During Fires.

By C. W. Mowry (Member N.F.P.A.),
Associated Factory Mutual Fire Insurance Companies.

Fighting a fire is a race between the spread of the flames and the application of water. Minutes and even seconds count, and if sufficient water is used and promptly applied, the water usually wins early in the race. When it doesn't, a three-alarm fire or occasionally a conflagration results.

It is evident that the amount of water used will depend on three factors,—how soon it is applied after the outbreak of the fire, whether or not it is applied at the seat of the burning material and not wasted, and whether it is applied at a sufficient rate to drown the fire at the start. To illustrate these points concretely and to show the actual amount and rate of water consumption needed for fire fighting the following typical examples have been selected.

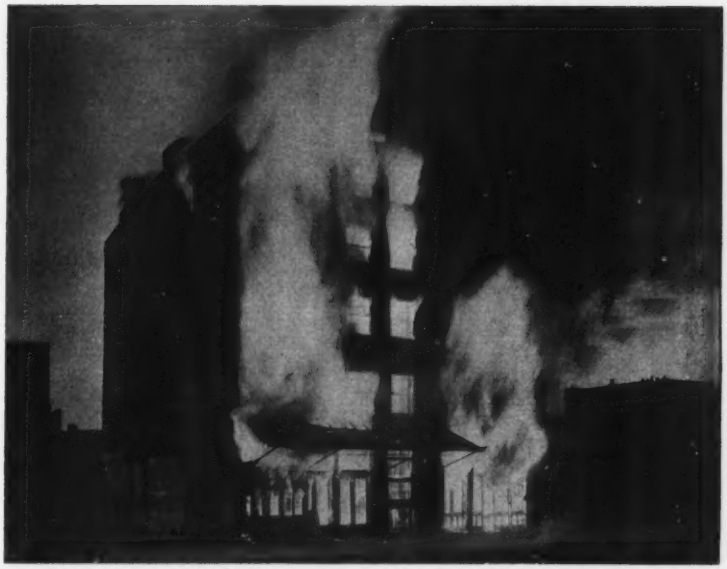
Bureau of Standards Fire Test, Washington, D. C.

The first example illustrates the speed with which a building will burn without the application of water. In a section of Washington where an entire city block was being razed, a unique fire test was conducted in 1928 by the U. S. Bureau of Standards. (QUARTERLY, July 1928, Vol. 22, No. 1.) Two adjoining buildings were selected for the test. One was 75 ft. by 30 ft., five stories high; and the other was 75 ft. by 20 ft., two stories high. Both buildings had brick walls and ordinary joisted floors and roofs. Each had an open stairway and elevator shaft. There were few partitions and there was nothing to obstruct the rapid spread of the fire throughout both structures. To represent the combustible occupancy of an office or mercantile building, waste lumber was spread on each floor.

About 5:30 o'clock one Sunday morning when weather conditions were favorable, the contents of both buildings were ignited simultaneously on the ground floor. Within five minutes, fire had spread up through the open elevator shaft to the top of the five-story building; and soon afterward, the entire contents of both buildings were involved. This clearly indicates the importance of the first five minutes in fire fighting.

Within twenty minutes, the wooden floor-joists were burning through and in twenty-eight minutes, a section of the front wall fell out, followed at short intervals by portions of the other walls. In three-quarters of an hour after the start, most of the walls above the first floor had collapsed and at the end of two hours, both buildings were completely burned down.

From a paper presented before the New England Water Works Association, September 30, 1931.



The fire test of the U. S. Bureau of Standards at Washington ten to twenty minutes after starting fire simultaneously in the first story of both buildings. No water applied.

Fall River, Mass., Conflagration.

The second example illustrates what can happen in a city with an excellent public water system and a first class fire department, when fire gets a good start before it is discovered.

In the business center of Fall River, Mass., fire was discovered in the first story of one of the vacant Pocasset Mill buildings at about 6:30 in the evening of Feb. 2, 1928. In anticipation of razing the plant, the automatic sprinklers had been taken out, and holes had been cut in the heavy plank floors for lowering machinery. Although the mills were located within two blocks of fire department headquarters the fire had secured a firm foothold before being discovered.

First alarm companies were unable to check the spread of the fire into the upper stories of the six-story stone mill and a general alarm was sounded seven minutes after the first. Hose streams could not be brought into action quickly enough in the crowded mill yard to stop the fire, which jumped to adjoining buildings and continued to spread. Outside aid was called, eventually bringing assistance from twenty-one cities and towns, which sent thirty-two pumpers and three hundred and forty-eight men. This is not only an excellent example of how modern automobile pumping engines can quickly rush aid long distances to a city where a fire is out of control, but indicates

The business center of Fall River in ruins, February 2, 1928.

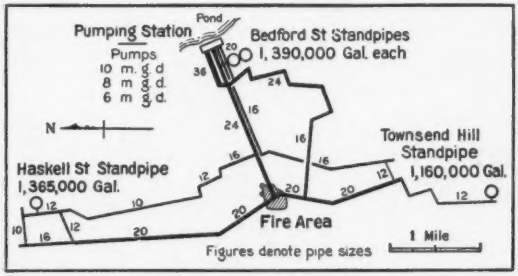


Diagram of main feeders at Fall River, Mass., showing how the distribution system became a concentration system during the fire.

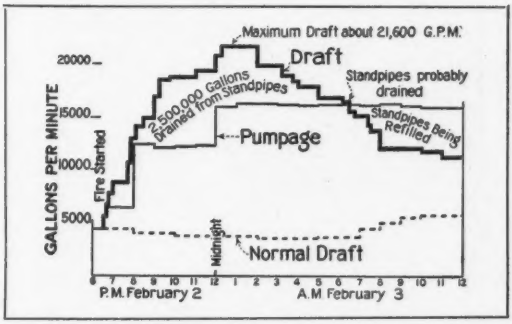
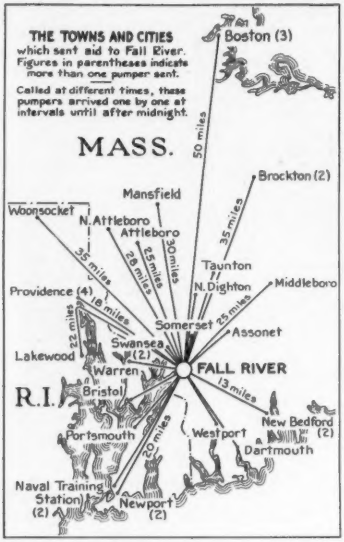


Chart of water consumption during the conflagration showing how standpipes helped to meet the peak demand of 31 m.g.d., or 7 m.g.d. above pumping capacity.

how much greater the concentrated peak demand upon a public water system may be than it was before the advent of the modern automobile pumper.

The Fall River water works had at that time three pumps of 10, 8, and 6 million gallons per day capacity, respectively. There were also four standpipes with a total capacity of 5,300,000 gallons, from which large supply mains led to the center of the city, where normal pressure is about 70 pounds. When the fire broke out, the standpipes were full and the 10 m.g.d.* pump was supplying normal demands, then at the rate of 5¼ m.g.d. This pump was speeded up soon after the alarm of fire, and the 8 m.g.d. pump was started an hour later. After the out-of-town pumpers began to arrive and connect to the city mains, the heavy drafts exceeded the capacity of the two pumps which were operating, so that shortly after midnight the 6 m.g.d. pump was also started, bringing the total pumping delivery up to 24 m.g.d. The consumption, however, which reached a maximum of 21,600 g.p.m., or 31 m.g.d., exceeded the capacity of the pumps 7 m.g.d., and had emptied two of the standpipes by 6:00 o'clock the next morning. Fortunately, the fire was under

*The rates of flow in this paper are expressed in millions of gallons daily, the usual nomenclature of water works engineers. One m.g.d. is approximately equal to 700 gallons per minute.



Factory Mutual Record.

control at this time after destroying six city blocks with a loss of $2,550,000. All three pumps were kept in operation until the standpipes were refilled. It is estimated that over 20,000,000 gallons of water were used to fight this Fall River fire.

Although in the average city, only a fraction of one per cent of the total water pumped is used for extinguishing fires, yet the rate of consumption during a large fire may be higher than the capacity of the system, as it was at Fall River. This is especially true today when out-of-town pumpers can be so quickly concentrated.

Cocheco Cotton Mill Fire, Dover, N. H.

The third example will illustrate how much water may be required to fight a difficult fire which has a ten-minute start.

The Cocheco Cotton Mill at Dover, N. H., was five stories in height, with brick walls and heavy plank and timber floors and roof. It was equipped throughout with automatic sprinklers, having the primary water supply from the public mains, static pressure 115 lb., and a flowing capacity of 1500 g.p.m. at good pressure. Four fire pumps were also available on the sprinklers and yard hydrants, with a pumping capacity of 3700 g.p.m.

At 6:30 one Sunday morning, while the sprinkler system was shut off temporarily to replace a sprinkler head, fire started in the third story. It spread so rapidly that some of the operatives jumped from windows, some slid down ropes, and five were overcome and died. Only a ten to twelve-minute delay elapsed before the sprinkler valve was reopened, and yet so many sprinklers had operated before the water was turned on that even the excellent public supply could not maintain adequate pressure, and all four fire pumps were started.

When hose streams were brought into action, the pressure was too low for the sprinklers. The sprinkler valve was, therefore, closed and opened at three-minute intervals to furnish good pressure alternately to the sprinklers and hose lines. The temperature was below zero and fire fighting was difficult, but by noon the rapid progress of the fire had been checked, although it continued all afternoon and night.

About three hours after the start of the fire at the Cocheco Mill. Water pressure not sufficient for upper-story sprinklers and hose streams at same time.

At the beginning of the fire, the public reservoir contained about 1½ million gallons, and the water works pump, with a capacity of 2½ m.g.d., was started. After about eleven hours of fire fighting, the level of the reservoir was dangerously low, and the city water was shut off from the plant. The estimated amount of water supplied from several sources during this fire is as follows:

City water	1,900,000 gal.
Fire pumps from river	5,500,000 gal.
Fire engines from river	800,000 gal.
Total	8,200,000 gal.

This experience is a good illustration of the advantage of having a practically unlimited auxiliary water supply from fire pumps at large industrial plants, even when there is an excellent city water supply, as there was in this case. The Cocheco fire also illustrates the danger of having automatic sprinklers shut off for even ten minutes. When sprinklers are supplied with adequate water at good pressure they extinguish fires more promptly and make less demands on a public water system than the use of large hose streams.

Nashua, N. H., Conflagration.

So far, we have been discussing the rapidity with which fire would burn, the consequent importance of applying water quickly, and the relation between the speed of application of water and the amount required. Another factor which influences the amount of water used on a fire is whether or not the water can be applied directly on the burning material at the beginning of the fire.

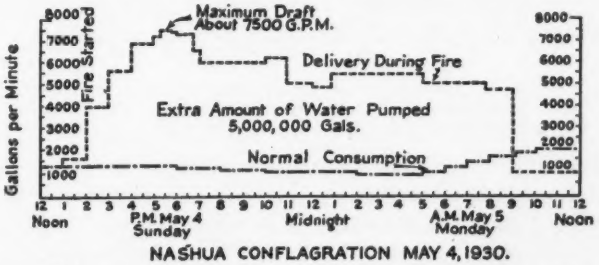
International.

Starting from a seemingly insignificant blaze on a railroad bridge, a conflagration swept through a manufacturing and residential section of Nashua, N. H., on May 4, 1930, for more than a mile, causing a loss estimated at $2,500,000.

The disastrous fire in Nashua, N. H., illustrates what may happen when water cannot reach the fire at the start. On Sunday afternoon, May 4, 1930, fire started in an old wooden railroad bridge covered on the top and sides by wood sheathing. The fire department soon had four or five strong streams playing on the bridge, but they were ineffective because they could not reach the seat of the fire, which was inside the covered structure.

Sparks and brands from the light sheathing were carried by the wind, igniting buildings to leeward, many of which had shingled roofs. The entire fire department could not cope with the rapidly spreading fire, which burned over an area more than a mile long and a quarter of a mile wide, containing two factories, several lumber yards, and numerous dwellings. The first call for help was sent to outside towns within one-half hour. Nineteen cities and towns sent twenty-six pumpers and three hundred firemen.

The maximum draft during the fire was about 7,500 g.p.m. or 10.8 m.g.d. About 5,000,000 gallons of water in excess of normal consumption is



NASHUA CONFLAGRATION MAY 4, 1930.

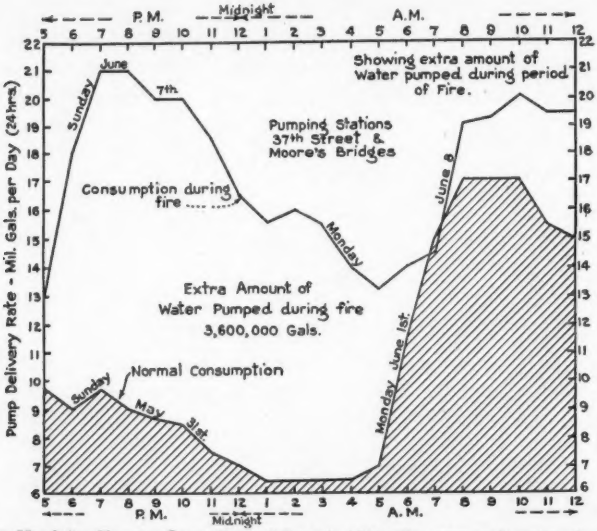
Water consumption during the Nashua conflagration. Fire occurred on Sunday when normal consumption was low.

estimated to have been used during the fire. A 6 m.g.d. pump was operating when the fire started, and for the first three hours this pump and the 4,000,000-gallon reservoir supplied the water needed. Then an 8 m.g.d. reserve pump was started. The pumps supplied most of the water, for the reservoir lost less than 1,000,000 gallons.

The conflagration placed an extremely heavy demand on the distribution system. Added to the fire draft was the wastage from broken service connections and some abandoned hose lines. Larger mains than the 8 in., 6 in., and 4 in. gridiron within the fire zone might have saved some buildings along the edge of the burned area, but probably would not have much reduced the rapid spread of the conflagration.

Armory Fire, Buffalo, N. Y.

The 106th Field Artillery Armory of Buffalo, New York, was completely destroyed by fire on the evening of May 6, 1931, largely because of the difficulty of getting at the seat of the fire at the start.



The Norfolk, Va., conflagration of June 7, 1931, also occurred on Sunday when normal consumption was low. Had the fire occurred a day later, the peak of the fire-draft would have been added to the heavy Monday morning consumption.

The fire occurred at 9:50 P.M. while members of the American Legion were drilling in the Armory. Smoke was observed coming up from the basement through a crack in the floor, and an alarm was immediately given. When the fire department arrived they could not enter the basement on account of the smoke, and were forced to use cellar pipes through holes chopped in the floor. These appliances proved ineffective because of the tremendous area of the building, which prevented the water from reaching the seat of the fire.

Additional alarms were sounded, bringing 36 engine companies, but in spite of this large force, the fire spread rapidly through the building, causing almost total destruction. Flying brands started more than 75 other fires on roofs in the district to the north of the Armory.

The Buffalo Water Department estimates that the maximum rate of water consumption used at the Armory fire was 6550 g.p.m. for three hours, and that in addition, at the other simultaneous fires within a mile of the Armory, 2660 g.p.m. were used for 1½ hours, or a total of 9210 g.p.m.

Another large fire in Buffalo occurred on November 6, 1928, during which a number of large, old buildings were involved, with a loss estimated at $500,000. The quantity of water used in fighting this fire is as follows:

City mains	13,500 g.p.m.
High pressure system	6,000 g.p.m.
Fire tugs	4,000 g.p.m.
Total	23,500 g.p.m.

Norfolk, Virginia, Conflagration.

A recent fire which reached conflagration proportions occurred on June 7, 1931, in the waterfront and wholesale district of Norfolk, Virginia, calling out all the available fire department equipment and personnel in the city. Twelve pieces of apparatus were sent from surrounding towns, as well as five hundred men from the Norfolk Navy Yard. Four pier sheds and approximately sixty other buildings were either destroyed or badly damaged, involving an estimated property loss of $1,250,000.

From an official estimate, about 3,600,000 gallons of water above normal consumption was supplied by the public mains for this fire, in addition to that delivered by the fire boat and various harbor tugs. The fire chief reported no shortage of water during the fire.

Spencer, Iowa, Conflagration.

Pumpers were used in an unusual way to supplement the public water supply during a serious fire in Spencer, Iowa, June 27, 1931. This fire, which started in a drug store, swept through three blocks in the principal mercantile section of this town of 5000 population, destroying 27 buildings with a loss of $750,000.

Spencer, Iowa, June 27, 1931. Pumpers were used to draft water from a river and spray pond of a local public utility, when a conflagration taxed the resources of the municipal water supply.

TABLE 1.

Water Consumption During Typical Sweeping City Fires and Conflagrations.

Location Date Fire Loss	Maximum Fire Flow	Maximum N.B.F.U. Standard	Peak Rate Domestic and Fire	Max. Daily Domestic Rate	Total Pumping Capacity	Extra Water Used	Duration of Fire	Remarks
	m.g.d.	m.g.d.	m.g.d.	m.g.d.	m.g.d.	mil. gal.	hours	
Norfolk, Va., June 7, 1931, $1,250,000	12.	14.4	21.*	14.2	61.	3.6	6½	Fire on Sunday. Ample water.
Nashua, N. H., May 4, 1930, $2,500,000	9.	7.2	10.8*	4.6	14. 4 mil. gal. res.	5.	9	Fire on Sunday. Pumps and res. ample. Mains overtaxed. Pressure exhausted in fire area.
Fall River, Mass., Feb. 2, 3, 1928, $2,550,000	26.2	14.4	31.*	9.3	24. 5.3 mil. gal. S.P's	20.	12	Ample water. Maximum demand exceeded pump capacity. 2.5 mil. gal. from standpipes.
Nashville, Tenn., March 22, 1916, $1,500,000	6.5	14.4	17.5	17.3	47 mil. gal. res.	—	4¾	Ample water generally, except at higher elevations. 50 m.g.d. pump limited to 20 m.g.d. by old force main to res.
Salem, Mass., June 25, 26, 1914, $8,000,000	22.	8.6	26.	4.1 Average high month	10. 20 mil. gal. res.	16.	13	Emergency connections to 3 towns used. Cement-lined mains burst. Water inadequate.
Chelsea, Mass., April 12, 1908, $12,000,000	21.	7.2	23.	6. Average high month	Large res. of Metropolitan System	29.	7½	Fire on Sunday. Good water supply and gridiron. Pressures became low due heavy draft and broken pipes.

In the above table water consumption has been indicated in million gallons per day, the standard nomenclature of water works authorities. 1,000,000 g.p.d. is approximately 700 g.p.m.

*Additional details in text.

The municipal pumping station contained a 1000 g.p.m. motor-driven, centrifugal pump, and a 600 g.p.m. steam piston pump. When the fire department pumpers of Spencer and other surrounding towns overtaxed the capacity of the municipal water supply, some took suction from the spray pond of the municipal electric generating station, others were stationed at a pond in a gravel pit, and still others were located at a river about ¼ of a mile south of the fire and pumped into street hydrants to augment the water supply during the fire. A maximum of twelve hose streams was used.

Warnings that the city water was polluted were posted throughout the town from Saturday evening, when the fire occurred, until Monday afternoon, when the water was again safe for use.

Indianapolis, Ind., Water System.

The Indianapolis Water Company at Indianapolis, Indiana, has made large expenditures to reinforce its water supply system and increase the pressure and volume for public and private fire protection service. For some time the Water Company has engaged in a campaign to increase the number of private fire protection installations, and more than three hundred are now in service. Not a single large fire has occurred in Indianapolis during the past five years in any property well protected by automatic sprinklers. Practically every fire of any magnitude has occurred in a property, the owners of which had been unsuccessfully solicited by the Water Company, urging some sort of private fire protection installation.

General Experience and Requirements.

The generally accepted standard for the total quantity of water which should be available for fire service in the average city is that in the Standard Grading Schedule of the National Board of Fire Underwriters. Typical quantities according to this standard are as follows:

Population	Required Maximum Fire Flow g.p.m.	Population	Required Maximum Fire Flow g.p.m.
10,000	3,000	60,000	7,000
13,000	3,500	80,000	8,000
17,000	4,000	100,000	9,000
22,000	4,500	125,000	10,000
28,000	5,000	150,000	11,000
40,000	6,000	200,000	12,000

For cities of more than 200,000 population the fire flow should be 12,000 g.p.m., plus 2000 to 8000 g.p.m. additional for a second fire.

Table 1 shows the actual peak rate of water consumption and the maximum fire flow during six typical sweeping fires. It also shows for comparison the recommended maximum rate according to the standard of the National Board of Fire Underwriters, the maximum daily domestic rate, and the total pumping or reservoir capacity. The fire flow which should be available for a serious local fire, according to the Grading Schedule of the National Board of Fire Underwriters, is from 3000 to 6000 g.p.m.

Quoting from the 1925 Manual of Water Works Practice of the A.W.W.A.:

The duration of maximum fire flow for which provision should be made is suggested as six hours, and such basis of design is quite common in the smaller cities and towns where dependence for fire supply is placed in part upon storage in standpipes or elevated tanks. The Underwriters recommend five hours fire flow for towns of less than 2500 population, and ten hours for larger communities.

It will be noted from examples of serious local fires given in Table 2 that the foregoing recommended rates of flow from the public mains were exceeded at the Baltimore *Post* fire (see page 279), and that the recommended duration of fire flow was exceeded at the Cocheco Mill fire. It is not at all

TABLE 2.
Water Consumption During Severe Localized Fires.

Location Occupancy	Date and Fire Loss	Maximum Rate of Consumption. (Fire only.)			Duration of Fire	Extra Water Used
			g.p.m.	m.g.d.	hours	mil.gal.
Baltimore Post, Baltimore, Md. Newspaper Office.	Jan. 1, 1931 $156,000	City Mains	9,000	12.9	2	1.6
		High Pressure System	9,000	12.9		
		Total	18,000	25.8		
Buffalo, N. Y. Group of old buildings.	Nov. 6, 1928 $500,000	City Mains	13,500	19.4		
		High Pressure System	6,000	8.6		
		Fire Tugs	4,000	5.8		
		Total	23,500	33.8		
106th Field Art. Armory, Buffalo, N. Y.	May 6, 1931 $7,000,000	City Mains	9,200	13.2		
C. B. & Q. R. R., Chicago, Ill. Office Bldg. and Adjoining Prop.	Mar. 15, 1922 $5,000,000		16,600	23.9	1½	16.8
Union Switch & Sig., Swissvale, Pa. Machine Shop.	Feb. 10, 1917 $2,250,000	City Mains	4,750	6.8	6	2.1
		Fire Pumps	2,000	2.9		
		Pumpers	500	—		
		Total	7,250	10.4		
Baldwin Loco. Wks., Philadelphia, Pa. Machine Shop.	Jan. 29, 1907 $150,000	City Mains	3,850	5.5	1	1.1
		Fire Pumps	2,750	4.0		
		Total	6,600	9.5		
Cocheco Mill, Dover, N. H. Cotton Mill.	Jan. 26, 1907 $480,000	City Mains	3,000	4.3	10½	
		Fire Pumps	2,500	3.6		
		Pumpers	700	—		
		Total	6,200	8.9		8.2

International.

Drowning a fire with seventy-five tons of water a minute. The Baltimore Post Building fire, January 1, 1931.

unusual today to use 20 to 30 hose streams (5000 to 7500 g.p.m.) to fight three and four-alarm fires.

High Pressure Systems.

To supplement the regular municipal water systems during these emergencies and furnish auxiliary water supplies of large volume, high pressure fire systems are installed in the high value districts of many large cities and special fire pumps are provided in large industrial plants. The capacities of representative high pressure fire systems and private fire systems are given in Tables 3 and 4.

The value of a high pressure system is well illustrated by the fire-fighting methods employed when the Baltimore *Post* Building burned last January. The fire trapped eight men in the upper floors. The first work was naturally that of rescue, and all were saved by ladders, except one who fell from a fourth-story window and was killed. Then close range, inside fire fighting was followed until there was danger that the floors might collapse.

By that time flames from the windows were endangering near-by buildings and it was decided to drown the fire with all available equipment. Pumpers supplied twelve hose lines from the regular hydrants, and the high pressure system supplied thirty-four lines, some feeding wagon guns and water towers.

The maximum rate of delivery to fight the fire and protect surrounding property exceeded 18,000 g.p.m. It was estimated that 1,600,000 gallons of water was used in the first two hours.

Summary.

Many other examples could be given to demonstrate what large demands may be made suddenly on public water systems in order to control serious fires, but enough have been cited to illustrate the general principles that apply to the study of water consumption during fires. These may be briefly summarized as follows:

1. Most fires are extinguished promptly by first aid equipment, by one or two hose streams, or by a few sprinklers. Therefore, the amount of water used is ordinarily small, but will be greatly increased if there is appreciable delay in applying the water after the outbreak of the fire, if the rate of application is not sufficient at the start, and if the water is not applied directly at the seat of the fire.

2. The peak load on public water systems for large fires is greater today than formerly because the mobility and speed of modern automobile fire apparatus enable large pumping capacities to be quickly concentrated in any city where needed.

TABLE 3.

Representative High Pressure Fire Systems.

City	Number of Pumps	Maximum Pressure	Capacity g.p.m.	Capacity m.g.d.
Atlantic City	9	150	12,000	17.3
Baltimore	3	210	12,700	18.3
Boston	4	200	19,000	27.4
		300	12,300	17.7
Buffalo	3	200	9,000	12.9
Cleveland	4	270	10,000	14.4
Detroit	6	300	15,000	21.6
Manhattan, N. Y.	12	300	36,000*	51.9
Brooklyn, N. Y.	8	300	26,400	38.0
Coney Island (Now)	3	150	4,500	6.5
Under Construction	5	225	13,500	19.5
Philadelphia	20	300	21,450	30.9
San Francisco	8	300	24,000	34.6
Winnipeg, Man.	3	300	10,800	15.5

*Heaviest draft was in 1909 for five fires or more. Seven pumps delivered 34,000 g.p.m. at 225 lb. per sq. in. average pressure.

3. Although the amount of water used annually for fire fighting in the average city is less than one per cent of the total amount pumped, yet when a fire obtains a good start, the maximum rate of water consumption needed to control the fire and supply all other demands simultaneously may exceed the capacity of the regular water system. (See Tables 1 and 2, and National Board of Fire Underwriters Standards on page 277.)

4. This possible sudden large demand is the reason why supplementary water supplies of large capacities are provided in the form of special high pressure fire systems for municipalities, and in the form of private fire pumps for individual properties of considerable value or hazard. (See Tables 3 and 4.)

TABLE 4.

Typical Private Fire Systems for Industrial Properties.

Location	Number of pumps	Maximum Pressure lb. per sq. in.	Capacity g.p.m.	Capacity m.g.d.
Lowell, Mass. Locks & Canals System Supplies 9 Plants	9	80	18,500 Also 4,000 g.p.m. from 2 mil. gal. reservoir at 60 lb. per sq. in	26.6
Lawrence, Mass. Supplies 8 Plants	23	100	27,000	38.9
New Bedford, Mass. Supplies 4 Plants	12	100	14,000	20.2
Moline, Ill. Supplies 9 Plants	10	100	10,000	14.4
Gatineau, P. Q. One Paper Mill	4	135	10,000	14.4
Three Rivers, P. Q. One Paper Mill	4	100	8,000	11.5

A Unique Fire Station Plan.

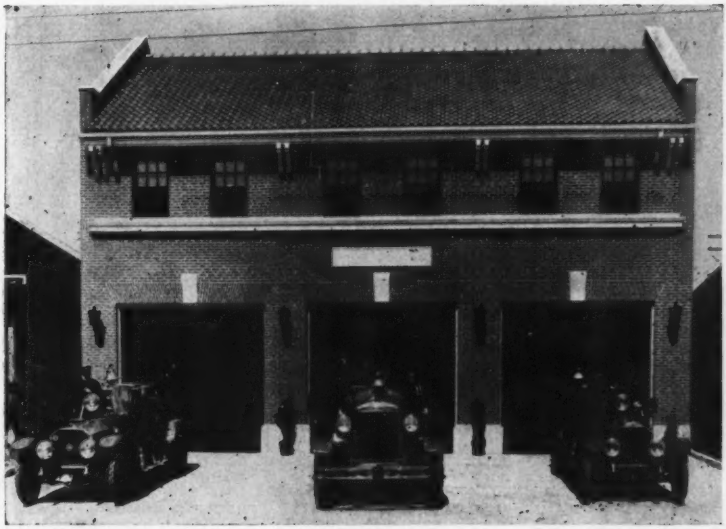
By C. H. Pike, Jr., Inspector,
West Virginia Inspection Bureau (Member N.F.P.A.).

Two new fire stations have recently been placed in commission in Wheeling, W. Va., as a result of the forethought and resourcefulness of a group of public spirited citizens, led by Mr. Charles J. Schuck. These far-sighted business men, realizing the need for new buildings and knowing that the bonded indebtedness of the city would not permit another bond issue, conceived the idea of forming a company to build the stations and to rent them to the city under a lease agreement satisfactory to both parties. With this in mind, and with the approval of the city officers, the Wheeling Fire Station Association was incorporated and the following plan evolved.

In order to raise the $90,000.00 necessary to construct these stations, $270,000.00 was guaranteed by the guarantors of the agreement, and a copy of the agreement attached to the notes given the various Wheeling banks. The business and professional men of the city who signed as guarantors pledged from $1,000.00 to $5,000.00 each and are responsible for the amounts appearing after their names in case of any default.

Cresco Photo Service.

Central Fire Station, Wheeling, W. Va., made possible through the public spirited activities of a group of business men, who guaranteed the funds essential for its construction.



Cresco Photo Service.

Edgewood Fire Station, Wheeling, W. Va., a modern station of reasonable cost.

The city in turn conveyed to the association by deeds the sites and improvements constituting its former fire station locations. Upon the signing and delivering of these agreements the association agreed to construct suitable buildings from plans that were satisfactory not only to the Trustees, but also to the chief executive officer of the city and to a majority of the members of the committee selected by the city.

Upon completion of the buildings the city accepted them for a term of four years, at an annual rental of $7,500.00, plus such sums as are necessary to pay interest on notes, insurance premiums, taxes, maintenance, or protection of property. If at the termination of this lease the city does not purchase these stations, the lease is to be renewed for six years, either by two three-year leases or one six-year lease under the same terms as the former lease.

By virtue of this plan the city will have paid the entire cost of the construction of these stations and at that time, or at any time that the city pays all charges against this property, the association will deed the property to the city free of all indebtedness.

The Central Fire Station is a modern two-story, semi-fire-resistive building, costing $60,000. The first floor is occupied by three pieces of motorized fire equipment as well as machines used by the fire chief and his assistants. Space is also provided for the storage of the motorized police equipment. On the second floor are quarters for fourteen men, private room for the

chief, the battery room and the central control room for the fire alarm.

In the basement provision has been made for washing hose and caring for other equipment. The hose tower is equipped with modern hose hoisting machinery, and all minor equipment is of the latest and most up-to-date type. Every convenience for the men has been furnished, including showers, a kitchen and a clothes drying room.

The Edgewood Station is somewhat smaller, being designed for a three company station. It replaces two smaller stations both located in the district. This building, like the Central Station, is a modern two-story, semi-fire-resistive structure containing all up-to-date equipment. Two engine companies at present are quartered in this station.

Tests of 1 and 1½-inch Fire Hose.

By Roy Bainer and K. R. Frost,
California Agricultural Experiment Station.

The use of hose for fire-fighting purposes in suburban and rural districts has brought about problems of correct size to use for various capacities and pressures required in order to obtain the best fire-fighting results and still keep the weight of hose to a minimum. Tests were conducted by the agricultural engineering division of the University of California, using 1 and 1½-inch standard rubber-lined, cotton-jacketed fire hose to determine friction losses under various discharges. The hose used in the tests was thoroughly examined as to roughness, composition, and dimensions. An inside view of the hose indicating the approximate roughness is shown in Fig. 1. The rubber lining yielded very readily to form as the hose was laid, leaving no wrinkles or rough areas where the hose was curved.

The 1-inch hose measured 15/16 inch inside diameter under zero pressure, increasing to 1 1/16 inches under a pressure of 150 pounds per square inch. The 1½-inch hose measured 1 7/16 inches inside diameter under zero pressure and 1 9/16 inches under a pressure of 150 pounds per square inch. In both cases the diameter increased ⅛ inch due to hydrostatic pressure. With the above dimensions, under a pressure of 150 pounds per square inch, the area of the 1-inch hose was 0.89 square inch and of the 1½-inch hose was 1.92 square inches, giving a ratio of 2.16 to 1. Therefore, discharges from the 1½-inch hose and 1-inch hose were at the ratio of 2.16 to 1 when other factors were equal.

Pressure gages were placed at regular intervals between 100-foot lengths of hose. The difference between the gage readings gave the loss due to friction for that interval in pounds per square inch. Five 100-foot lengths of 1-inch hose, with gages connected at 100-foot intervals were used in testing the

Reprinted from *Agricultural Engineering*, the journal of the American Society of Agricultural Engineers.

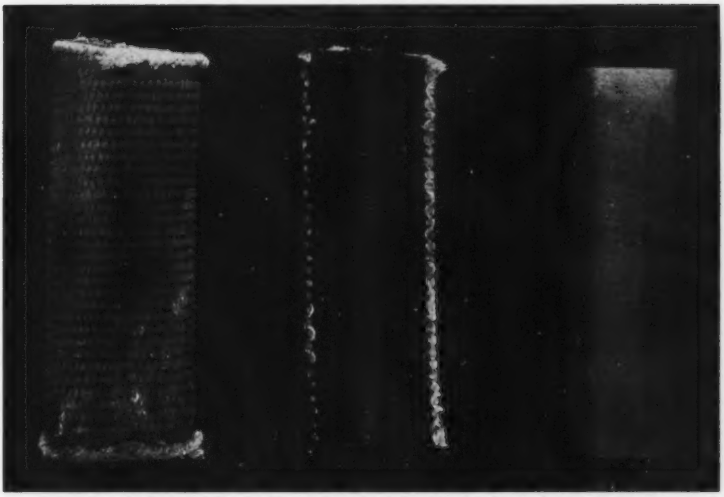


Fig. 1. Exterior view of one-inch rubber-lined, cotton-jacketed fire hose, with cross-section and plaster of Paris cast.

small hose. The difference in gage readings made it possible to obtain a fairly accurate value for the loss in the line. The five different intervals gave a good average loss per 100 feet of hose.

The length of 1½-inch hose used was 1000 feet with gages at intervals of 200 feet. This interval and length were necessary in order to obtain good average results as the friction was much lower than for 1-inch hose, especially for low discharges. The gages were placed in a vertical position to make accurate reading easier.

In all cases where the discharges were varied, the pressure drop varied approximately as the square of the velocity (Fig. 2). As very clearly illustrated by these curves, the pressure drop for the same discharge was much greater for 1-inch hose than for 1½-inch hose. The cross-sectional area of the 1½-inch hose being over twice that of the 1-inch hose, the velocity in the latter was over twice that in the former at a given discharge, and the friction loss more than four times as high. In comparing the two sizes of hose (Fig. 2) using maximum discharges the loss for 100 feet of 1-inch hose discharging 30 gallons per minute was 28 pounds per square inch, while the 1½-inch hose showed a loss of only 13 pounds per square inch for 60 gallons per minute. Values taken from these curves show that it would be impossible to maintain the pressure necessary for extinguishing fires at distances much over 500 feet from the pump with discharges greater than 20 gallons per minute, operating with 1-inch hose. Practical operation could be secured with the 1½-inch hose with discharges under 40 gallons per minute at 1000 feet from the pump.

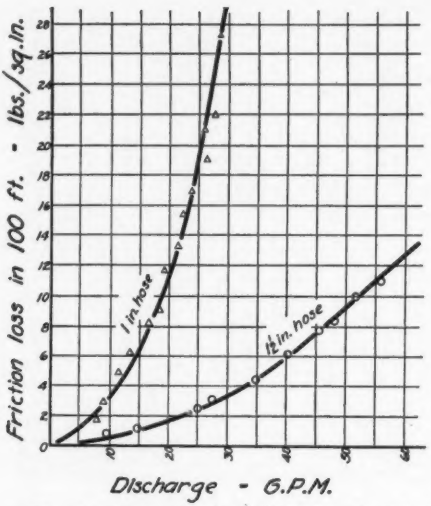


Fig. 2. Curves showing friction loss in 1-inch and 1½-inch rubber-lined canvas fire hose.

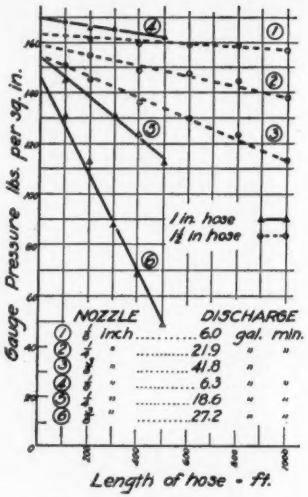

Gauge Pressure lbs. per sq. in.
1 in. hose
1½ in hose
NOZZLE DISCHARGE
① ⅞ inch ..... 6.0 gal. min.
② ¾ " ..... 21.9 " "
③ ⅝ " ..... 41.8 " "
④ ½ " ..... 6.3 " "
⑤ ⅜ " ..... 18.6 " "
⑥ ¼ " ..... 27.2 " "
Length of hose - ft.

Fig. 3. Pressure drop per 100 feet of same hose under varying discharges.

Fig. 3 also illustrates the fact that, if the discharges can be decreased to very low figures, the length can be materially increased for both sizes of hose. If the hose is used only for transportation of water along the fire line and not directly under pressure, the loss due to friction is not so important. In this case the size of hose that carries a capacity equal to the amount of water desired will be the one used. Pressures of 150 pounds per square inch can be maintained by most rural fire truck pumps when discharging 35 to 50 gallons per minute. This will maintain a discharge of 30 gallons per minute at a pressure of 50 pounds per square inch at 500 feet for 1-inch hose and 40 gallons per minute at a pressure of 110 pounds per square inch at 1000 feet for 1½-inch hose.

The sizes of nozzles ordinarily used for rural fire-fighting work are ⅛-inch, ¼-inch, and ⅜-inch. Grass and grain fires may usually be dealt with satisfactorily with ⅛-inch nozzles discharging 5 to 8 gallons of water per minute, although ¼-inch nozzles are necessary at times of high wind and when fighting bad fires. To determine the pressures obtainable with various nozzles with hose lengths up to 1000 feet tests were made, giving the nozzle discharge and the friction loss for each 100 feet. The pressures at various distances from the pump were plotted as shown in Fig. 3. The drop in pressure was directly proportional to the distance, hence the curve for each nozzle is a straight line. The pressure drop per 100 feet with a given nozzle and hose can be readily

obtained from these curves. The ⅜-inch nozzle on a 1-inch hose gave a drop in pressure of only 1½ pounds per square inch per 100 feet, discharging 6.3 gallons per minute at 500 feet distance, which is a satisfactory discharge for many cases. Therefore, if only 6 gallons per minute are required for 500 feet of hose, a 1-inch hose and ⅛-inch nozzle will be sufficient. If a discharge much greater than this is necessary, good results are obtained by a 1½-inch hose and ¼-inch nozzle giving a discharge of 22 gallons per minute with a hose length of 1000 feet. When the discharge necessary to extinguish the fire is less than 8 gallons per minute, the 1-inch hose has a decided advantage over the 1½-inch hose. The cost is less and weight of the 1-inch hose is only about one-half that of the 1½-inch hose. When a large volume of water is required the 1½-inch hose can be used with a ⅝-inch nozzle, giving a loss of 4.5 pounds per square inch per 100 feet at a discharge of 42 gallons per minute through 1000 feet of hose. Large volumes are needed in fighting structure fires.

Various positions of the hose were tried in order to study the effect of the radius of curvature upon the friction loss. The discharge was held constant for each test by a valve on the end of the line. Each test lasted five minutes and the water discharge for this time interval was weighed. For each position of hose, tests were run from maximum capacity available with a four-cylinder engine and 2-inch rotary pump to complete shut-off, from 10 to 15 runs being made for each position. The radius of curvature seemed to have a definite relation upon the friction loss. The definite radii of curvature used were 1, 2, 3, 4, 5, and 50 feet. The latter showed a loss, on the average, 1.5 pounds per square inch per 100 feet greater than the 5-foot radius. The losses for the smaller radii showed little variation, small enough to be negligible. This effect was not so pronounced in the case of small discharges up to 10 gallons per minute due to the very low velocity of the water. For a discharge of 25 gallons per minute through a 1½-inch hose the loss was 2¾ pounds per square inch per 100 feet, in the case of the 50-foot radius and 1¼ pounds per square inch per 100 feet in the 5-foot radius. This discharge is often used in the case of the ¼-inch nozzle for fire fighting, but there being only a difference of 1.5 pounds per square inch per 100 feet, this will cause only a slight effect upon the pressure at 1000 feet. Therefore, the position of the hose is far less important than the length of hose.

Summary.

1. One-inch hose can be used satisfactorily with ⅜-inch nozzle for distances up to 1000 feet and ¼-inch nozzle up to 500, while 1½-inch hose may be used with ⅝-inch nozzle for distances up to 1000 feet.

2. Friction varies in fire hose very nearly as the square of the velocity.

3. The differences in pressure obtained when the hose is laid in various positions are not of material importance.

Private Fire Brigade Results.

Endicott Johnson Corporation.

This story of the work of the Fire Prevention Department of the Endicott Johnson Corporation has been made possible through the courtesy of Chief James R. Eldridge, who has made available for analysis the original records of his department for the five-year period, 1926 to 1930 inclusive. The results of this analysis, included as part of this story, are a tribute to the efficiency of the Fire Prevention Department and form ample justification for its maintenance as an important division of the factory organization. The value of training all employees in fire prevention and extinguishment is clearly indicated. The tabulation of methods of extinguishment of actual fires is an excellent illustration of the effectiveness of first aid fire protection appliances when properly applied.

The Endicott Johnson Plant.

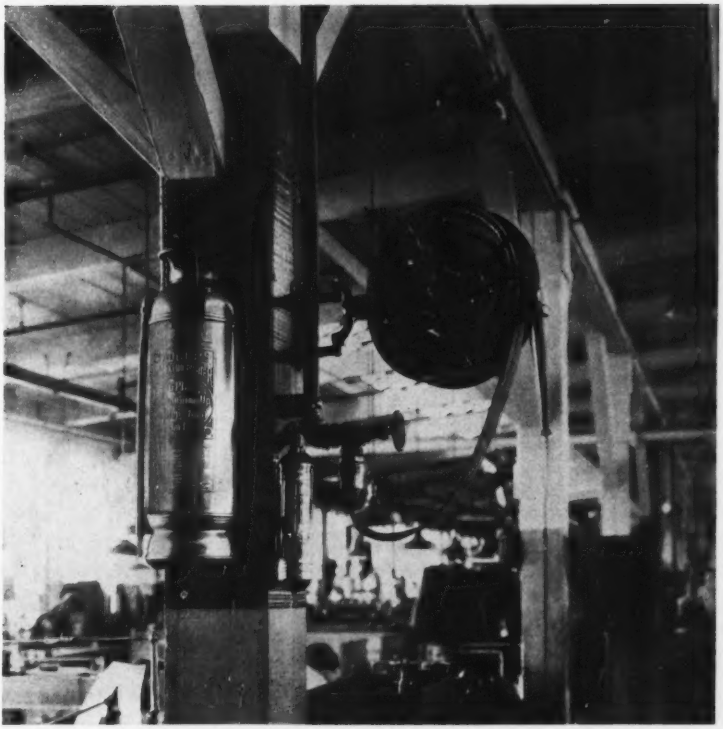
The principal manufacturing units of the Endicott Johnson Corporation are located in Johnson City, Endicott, West Endicott and Owego, N. Y., all within a radius of about twelve miles. In these four towns and villages there are thirty-four large factory groups with a total of 127 acres of floor space, where approximately 18,000 workers produce between 130,000 and 140,000 pairs of shoes daily. The welfare of these communities (the first three of which grew up around the factories) is closely bound up with the welfare of the company, and the Endicott Johnson payroll is an important factor in local prosperity.

The two largest manufacturing plant groups are those at Johnson City and Endicott. The former embraces the principal shoe manufacturing units, together with a fibreboard mill, a leatherboard mill, a rubber mill, a rubber reclaiming plant, a carton factory and a printing establishment. At Endicott are located the four large tanneries of the company, the sales offices and warehouse, a shoe factory and a lumber mill. Shoe manufacturing plants are also located at West Endicott and Owego. In addition to the manufacturing plants there are a considerable number of miscellaneous buildings occupied by the company for its own use or for the use of its employees.

The various buildings are of heavy timber frame, brick mill, or fire-resistive construction, with the frame buildings predominating. They are for the most part of large area, and range from one to six stories in height.

Fire Protection.

All principal buildings are equipped with automatic sprinklers and inside standpipes, while hose houses and hydrants are located at strategic points



Fire extinguishers and small hose at strategic locations, supplementing complete automatic sprinkler protection, have kept the Endicott Johnson Corporation fire losses at a very low figure. This picture shows a typical first aid fire station with a conspicuous red band painted on the column. Both soda-acid and carbon tetrachloride extinguishers are provided and employees are instructed as to the proper use of each type.

outside the buildings. Adjoining structures and sections of large area buildings are properly cut off by standard fire doors.

To provide this protection there are approximately 63,000 sprinkler heads, and 25,000 feet of 1¼-inch and 2½-inch hose located at easily accessible points throughout the plant. There are also nearly 1200 soda-acid and foam type extinguishers and 600 carbon tetrachloride extinguishers. Two hundred and sixty-six fire alarm stations are located in the various buildings. The water supply for the sprinklers, standpipes and fire hydrants is obtained from seven reservoirs having a total capacity of 12,680,000 gallons. Seven fire pumps, with a total rated capacity of 100,000 gallons per minute, are ready for operation at a minute's notice.

An interesting system of marking indicates the location of first aid fire fighting equipment in the plant. Posts on which are located 2½-gallon soda-

acid or foam extinguishers are identified by a red band three feet wide. A similar band 18 inches wide indicates a post on which one quart carbon tetrachloride extinguishers are mounted. The hose reel is on a post with a red band within 12 inches of the ceiling and a fire alarm box is to be found on a post with the upper half painted red. These identification marks increase the efficiency of the employees upon whom, to a large extent, rests the responsibility for the extinguishment of incipient fires during working hours.

Fire Prevention Department.

In addition to this extensive first aid fire fighting equipment there has been established a private fire brigade known as the Endicott Johnson Fire Prevention Department. This department, which is unique in many ways, is one of the most thoroughly trained and equipped industrial fire brigades in the country. Its duties include the prevention of fires, fire fighting and general emergency work in the plant.

The personnel of the department consists of Chief Eldridge, two assistant chiefs, four captains, four lieutenants, sixteen men detailed to ambulance work, six switchboard operators, a fire alarm supervisor and 82 full-time firemen. The last mentioned also serve as inspectors and watchmen. The apparatus consists of two motor hose cars carrying 2½-inch and 1½-inch hose, two service cars, three ambulances and a car for the chief. Equipment and personnel are housed in two standard city fire stations, one at Johnson City and the other at Endicott.

The actual work of fighting fires is but one of the numerous duties of the Fire Prevention Department. Even more important is the constant inspection of the plants which has prevented the start of many a fire. A complete check-up of every section of every building is made at each plant by a night patrol of forty men (twenty at each plant) and hourly reports are made to headquarters over the fire alarm system. These reports serve a dual purpose, indicating that conditions are satisfactory in the factory visited and testing the fire alarm system itself. A daily report on the condition of all fire fighting equipment throughout the plants is filed by department inspectors, which with the reports filed by the night patrolmen keeps the Fire Prevention Department in close touch at all times with plant conditions bearing on fire protection or prevention.

Close coöperation is maintained with the municipal fire departments in Johnson City and Endicott. Both of these departments are equipped with modern apparatus, secured through the company's help, and respond when required to assist the company's fire brigade. In return the Endicott Johnson fire fighters assist the municipal departments when called upon.

In training the fire brigade staff and the general factory personnel the same thoroughness has been shown as in planning the equipment. Weekly

school sessions are held at each fire station under the direction of one of the chief officers, and the men are instructed in any new method of fire protection or prevention, given instructions regarding newly added property, and examined for their knowledge of their duties.

Training in the use of fire appliances is also given to the factory workers, and frequent fire drills familiarize employees with orderly procedure in leaving the buildings in event of fire. Workers are acquainted with the various types of fire fighting appliances in their particular department and are instructed how to use them in event of fire. Certain employees are designated to operate the first aid fire appliances, others are detailed to sound an alarm immediately, while some are instructed to direct and guide their fellow workers from the building. Good housekeeping is stressed as an important factor in fire prevention and special emphasis is laid on the proper disposition of waste material.

Fire Record.

The work of the Fire Prevention Department in responding to alarms and fighting fires is indicated in a general way by the following table.

Year	No. of Fires	Equipment Used S. A. Ext.	CTC-Qts.	1¼" Hose	2½" Hose	Time on Duty H	M	Loss
1926....	122	61	54	1,550 ft.	8,100 ft.	49	33	$12,657.58
1927....	163	45	53	2,050 ft.	9,300 ft.	62	50	2,071.10
1928....	189	43	96	3,525 ft.	11,150 ft.	81	22	4,292.48
1929....	156	42	53	2,500 ft.	2,750 ft.	50	19	7,321.98
1930....	190	62	50	1,450 ft.	11,550 ft.	103	37	1,492.90
Total 5 Yrs.	820	253	306	11,075 ft.	43,050 ft.	348	41	$28,090.45

Number of Fires and Alarms.

The total number of alarms received was 820. This includes alarms from all sources, fire alarm boxes, telephone alarms, verbal alarms and reported fires. In many instances of incipient fires during working hours notification was not given the Fire Prevention Department until after the fire had been extinguished. For record purposes, however, such notifications are treated as alarms and are so recorded. The fires and alarms were classified by years as follows.

Class of Buildings	1926	1927	1928	1929	1930	Total
Shoe Manufacturing Buildings	46	39	43	52	51	231
Tanneries	24	22	28	37	44	155
Other Manufacturing Buildings	10	25	29	13	16	93
Non-Manufacturing Buildings	20	23	23	13	25	104
Other than Building Fires	22	54	66	41	54	237
Total	122	163	189	156	190	820

In order to properly analyze the methods used to extinguish the fires which have occurred during the five-year period under review, two classifications, "Fires in Buildings" and "Fires Outside of Buildings," have been made.

The fire station at the Johnson City plant, showing equipment used by the Fire Prevention Department. The three pieces of apparatus at the right are the Johnson City Fire Department, of which Chief Eldridge is also the head. The two departments coöperate to the fullest extent.

The first group accounts for 583, or 71 per cent, of the total fires and alarms and the second for 237. The fires in buildings were divided as follows:

	Bldg. Fires	Blower Fires	Total
Shoe factory buildings	186	45	231
Tannery buildings	88	67	155
Other manufacturing buildings	93	0	93
Non-manufacturing buildings	104	0	104
Total	471	112	583

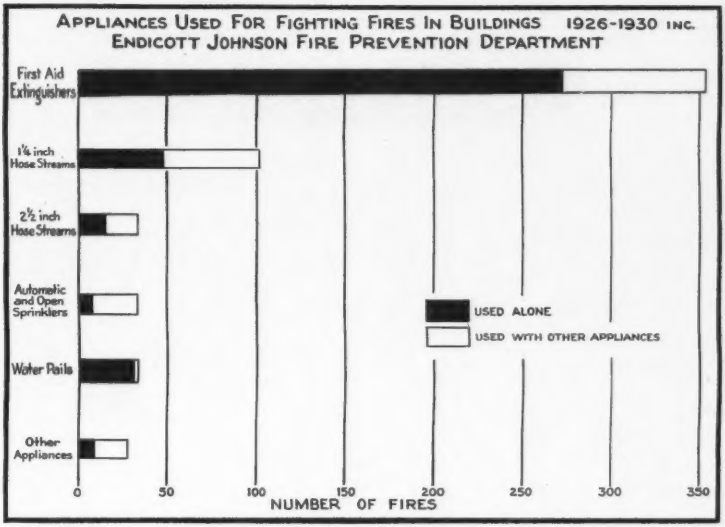
The fires outside of buildings were classified as follows:

Automobiles	16
Ball park	31
Dump fires	100
Leather dust	25
Grass fires	37
Miscellaneous	28
Total	237

Methods of Extinguishment.

As indicated by the following table, 675 fires required the use of fire fighting equipment of some sort, 128 fires were extinguished without the use of equipment and 17 calls were false alarms or needless. The 128 fires where no fire fighting equipment was required were of an incipient nature such as motor short circuits or possibly a quick flash occasioning no fire other than the initial flare.

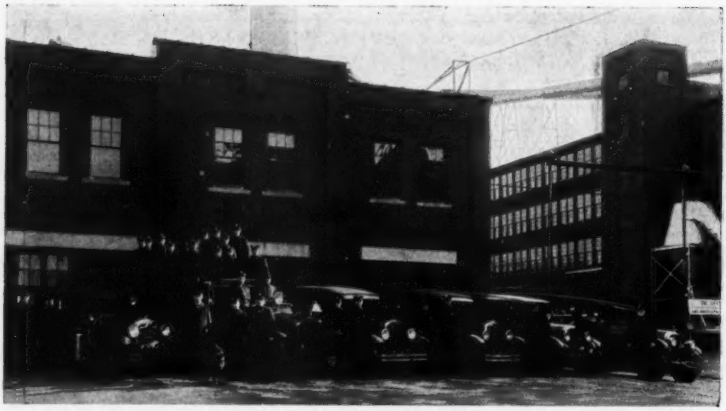
	Building Fires	Outside Fires	Total
No. of fires requiring use of fire fighting equipment	455	220	675
No. of fires where no fire fighting equipment was used	111	17	128
False or needless alarms	17	0	17
Total	583	237	820



Of the 455 fires in buildings that required the use of fire fighting equipment 320, or approximately 70 per cent, were extinguished by the use of portable first aid fire appliances without the additional assistance of automatic sprinklers or the use of hose streams. If the fires occurring in dust collector or blower systems, most of which required the use of hose streams, are eliminated, the effectiveness of first aid equipment is even more striking. In the tables which follow, fires occurring in blower and exhaust systems or in dust collectors have been listed as "blower" fires. There were 353 building fires exclusive of blower system fires, of which 315, or 89.4 per cent were controlled and extinguished by first aid appliances alone.

For fires outside of buildings hose streams were more frequently required. This is a natural consequence in view of the large number of dump and leather dust fires, the extinguishment of which required the use of one or more hose streams.

These figures are significant in that they clearly demonstrate beyond question the value of first aid fire appliances in fire extinguishment where proper training and education in their use and application have been given employees. Furthermore, they bear out the statement, appearing as a foreword to the N.F.P.A. Regulations for First Aid Fire Appliances, that "a small quantity of water or other extinguishing agent used intelligently at the start of a fire may easily be more effective than the work of an entire fire department five minutes later."



Endicott headquarters of the Fire Prevention Department, showing Company No. 2, ambulances and emergency car. The part frame shoe factory at the right of the picture is typical of the shoe manufacturing group at Endicott.

Fires in Buildings.

Appliances Used	Shoe Factories	Tanneries	Blower Fires	Other Mfg. Bldg.	Non-Mfg. Bldg.	Total
Carbon tetrachloride extinguishers..	58	27	0	53	27	165
Soda-acid extinguishers	40	9	2	15	22	88
1½-inch hose streams.....	3	2	42	0	2	49
Water pails	14	6	2	4	5	31
Soda-acid and carbon tetrachloride.	13	1	1	4	5	24
2½-inch hose streams.....	1	2	4	1	7	15
Soda-acid and 1½-inch hose streams.	2	1	7	1	0	11
1½-inch and 2½-inch hose streams...	0	0	9	0	0	9
Open sprinklers alone.....	0	0	6	0	0	6
Automatic sprinklers and soda-acid.	3	1	0	1	0	5
Hand hose.....	1	3	0	0	1	5
Open sprinklers and 1½-inch hose...	0	0	4	0	0	4
Foam extinguishers	0	0	0	0	3	3
Automatic sprinklers alone.....	0	1	0	1	0	2
Combinations of various appliances.	5	2	25	3	3	38
Nothing used	43	27	6	10	25	111
False alarms	3	6	4	0	4	17
Total.....	186	88	112	93	104	583

Fires Outside of Buildings.

Appliances Used	Automobiles	Ball Park	Dump Fires	Leather Dust	Grass	Misc.	Total
2½-inch hose streams.....	0	0	87	17	2	2	108
Soda-acid extinguishers	0	30	2	0	2	6	40
Wire brooms	0	0	0	0	27	0	27
Carbon tetrachloride extinguishers.	10	0	0	0	0	6	16
Water pails	0	0	2	3	0	2	7
Combinations of various appliances	6	1	6	3	3	3	22
Nothing used	0	0	3	2	3	9	17
Total	16	31	100	25	37	28	237

Fair Play shoe factory at West Endicott, one of the more modern buildings of the Endicott Johnson Corporation. Of brick mill construction, this structure is approximately 400 feet long. The blower system and dust collector shown in the foreground are typical.

Analysis of Protection Used.

Carbon Tetrachloride Extinguishers.

Carbon tetrachloride extinguishers were used 206 times for fires in buildings and 22 times for other than building fires. For the most part the extinguishers of this type used were of the 1-quart size. Larger size extinguishers were used on several transformer and generator fires. It is clear from the fire reports that carbon tetrachloride extinguishers were used in most instances where fire involved flammable liquids or electrical equipment. This demonstrates clearly the advantages of educating the factory workers as well as the staff of the Fire Prevention Department in the use of the proper first aid equipment for specific types of fires. Of the 22 fires not in buildings 13 were in automobiles or tractors. These extinguishers were used alone 181 times and in conjunction with other appliances 47 times. The greatest number used on a single fire was ten.

No. Used	No. of Fires
1	199
2	14
3	11
4	1
5	2
10	1
Total	228

The single instance of ten 1-quart carbon tetrachloride extinguishers being used was a motor fire. More than an hour was required to extinguish this fire, which was due to dirt in the motor.

Soda-Acid Extinguishers.

Soda-acid extinguishers were used 144 times for fires in buildings and 45 times for other than building fires. Of the other than building fires 30 were in the grandstand at the ball park, the remainder being grass, dump or miscellaneous fires. These extinguishers were used alone 128 times and

with other appliances 61 times. The greatest number used on a single fire was seven.

No. Used	No. of Fires
1	133
2	35
3	15
4	4
7	1
10*	1
Total	189

*Ten soda-acid extinguishers were used during a single afternoon to extinguish numerous incipient fires at the ball park. These were reported as a single fire to the Fire Prevention Department.

1¼-inch Hose Streams.

Small hose streams from standpipes or yard hydrants were used 17 times for fires in buildings, 84 times for fires in dust collectors or blower systems and 3 times for fires outside of buildings. They were used alone or with 2½-inch hose streams 61 times, and used to supplement first aid fire equipment 43 times.

The use of small hose streams for blower fires has been a material factor in keeping down losses from the excessive use of water. Fires in dust collecting systems once started are apt to travel through the system forced by draft created by the blowers. Small hose streams are easier to handle and more effective against this type of fire than are the larger hose streams, and obviously the damage incidental to their use is materially reduced.

2½-inch Hose Streams.

Of the 33 times that 2½-inch hose streams were used in buildings 19 times were for fires in dust collector systems where in all but four instances they were used to supplement other equipment. Of the remaining 14 fires, seven occurred in buildings used for other than manufacturing purposes and not directly under the supervision of the Fire Prevention Department. Fires other than in buildings required the use of 2½-inch hose streams 115 times, of which 108 were dump fires or fires in piles of leather dust.

Automatic and Open Sprinklers.

Automatic sprinklers operated 12 times for fires in factory buildings and 21 times for fires in miscellaneous buildings. In all but two instances other appliances were used to clean up the fire after the sprinklers had checked it. This is another indication of the effort made to prevent excessive water loss as well as fire loss. The sprinklers were shut off as soon as it appeared that the fire was under control and any smouldering remains were taken care of by first aid appliances. That automatic sprinklers did not operate more frequently may be attributed to the training of the factory employees who promptly used first aid appliances, controlling the fire before sufficient heat

was generated to open sprinkler heads. Most fires where sprinklers operated occurred at night.

The dust collector systems at the Endicott plant are partially equipped with a system of open sprinklers. These were operated at 19 fires, six of which were extinguished by open sprinklers alone and 13 by open sprinklers in conjunction with other appliances.

Other Fire Protection Used.

Other protection was used at a number of fires as indicated below. Perforated pipes were employed at the Endicott plant in ten fires in blower systems, in each instance in conjunction with other equipment. Water pails were also effective in 33 incipient building fires, being used alone 31 times.

Protection Used	Building Fires	Blower Fires	Other Fires	Total
Water pails	31	2	10	43
Wire brooms	0	0	31	31
Perforated pipe	0	10	0	10
Hand hose	5	0	1	6
Foam	3	0	1	4
Sand	0	0	2	2
Soda and Salt	1	1	0	2

Loss Record.

As a result of the efforts of the Fire Prevention Department the total fire loss for the five-year period in the entire group of 34 manufacturing groups was but $14,285.11, an annual average of $2,857.02. The losses were almost evenly divided between the Johnson City and Endicott plants. In addition to these losses in buildings under the jurisdiction of the department there were four other fires in company owned property which caused a total loss of $13,805.34, making an aggregate loss for the period for property owned by the Endicott Johnson Corporation of $28,090.45.

The losses occurring outside of the factory groups represented losses paid on two dwellings owned by the company at Endicott, a large barn at the Endicott Johnson farm and a workers' store at Johnson City. In each of these instances the Fire Prevention Department assisted the town fire department.

Record of Losses 1926-1930.

Class of Building	1926	1927	1928	1929	1930	Five-Year Period
Shoe Mfg. Plants	0	0	0	$1,632.62	$1,371.94	$3,004.56
Tanneries	0	$1,991.50	$575.00	100.00	17.50	2,684.00
Other Mfg. Plants	$3,340.70	54.60	0	30.00	0	3,425.30
Misc. Buildings	3,475.00	25.00	1,217.48	95.90	103.46	5,171.25
Dwellings	0	0	2,500.00	463.46	0	2,963.46
E. J. Farm Barn	0	0	0	5,000.00	0	5,000.00
Workers' Store	5,841.88	0	0	0	0	5,841.88
Total	$12,657.58	$2,071.10	$4,292.48	$7,321.98	$1,492.90	$28,090.45

Gasoline Tanker Fire.

By Clarence Heller,
(Member N.F.P.A.).

Three men lost their lives as the result of an explosion and fire on the tank steamer *Charlie Watson* at the Standard Oil Co. of California's docks in San Francisco on November 20, 1931. That the fire did not have more disastrous results may be attributed to the manner in which it was fought by the fire department.

When the explosion occurred the ship was about to complete unloading her cargo, which consisted of 265,000 gallons of gasoline contained in six tanks or compartments. Most of this had been pumped out, but gasoline was still being delivered through the hose to tanks ashore.

Story of the Fire.

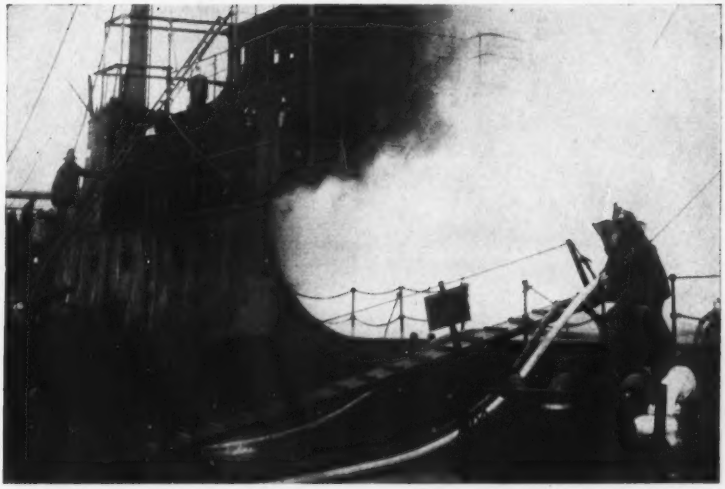
The initial explosion occurred shortly before noon when most of the thirty members of the crew were in the dining saloon. Suddenly the discharge hose from the steamer to the manifold on shore burst, allowing the gasoline to flow over the decks. An eyewitness reports seeing the gasoline discharging in a stream about like that from a garden hose.

Almost immediately the pump man stationed on the pier blew his whistle to stop the pumps and the chief officer and third mate, who were standing on deck, attempted to operate the shut-off valves. Before any action could be taken, however, the explosion took place. The pump man ashore was severely burned by the blast and the two men on deck were burned to death when their oil soaked clothing was ignited. As the men in the dining saloon rushed for exits, a second explosion shook the ship, injuring a number of the crew. Of these, one lost his life, the body being recovered from the bay later.

The exact cause of the break in the hose line and the source of ignition have not been definitely determined. The theory as to the source of ignition is that gasoline vapor found its way into the ventilation ducts and that when the officers of the ship saw the gasoline flowing on the deck and ordered the pumps shut down, the throwing of the switches produced an electric spark which ignited the vapor, causing an explosion in the deck house.

The second explosion followed the first by about a minute and enveloped the ship in a cloud of black smoke. Flames reached the tops of the masts and the superstructure of the ship was all ablaze when the fire department arrived.

A great deal of credit is due Chief Brennan of the fire department for preventing a more serious disaster. When he arrived on the scene the fireboat was standing off some distance and throwing streams at the burning ship,



International.

Firemen extinguishing fire on gasoline tanker "Charlie Watson" at San Francisco. That the fire did not have more disastrous effects is due to the concentration of hose streams at close range by the fire department.

and the men on the land side were doing likewise. This did not bring water to the seat of the fire so Chief Brennan ordered the fireboat alongside the burning vessel and personally led his men aboard the ship. The concentrated volume of water soon extinguished the fire and water was thoroughly circulated over the tanks so that their temperatures were kept down. This procedure obviously involved some risk to life, but its successful carrying out prevented the possibility of a much greater explosion and additional losses of life and property resulting therefrom.

The fire spread to the wharf and ignited timber beneath the pier deck. Firemen operating from small boats extinguished these secondary fires and confined the damage to the pier to not exceeding $500. The damage to the ship was considerable.

Ford Motor Plant Fire, Chester, Pa.

The danger of introducing a hazardous process in the main building of a large manufacturing plant and the mistake in connecting fire department pumpers to yard hydrants were two outstanding lessons of a serious fire on September 21, 1931, at the plant of the Ford Motor Company at Chester, Pa.

The building involved in the fire was a large single area structure of brick, glass and iron on a steel frame. One section was two stories in height and the other one story. Both sections had an asphalt and felt roof on wood joists.

A spray booth was located in the one-story section. From this booth two vent pipes extended through the roof adjacent to the monitor windows of the second story section. Both sections were protected by automatic sprinklers and the usual first aid devices.

Truck parts were prepared for foreign shipment by spraying them with a grease mixture to prevent rusting in transit. The parts traveled on a conveyor through a booth in which nozzles were supplied with this mixture by pumping from a 750-gallon open tank located beneath the floor of the booth. This operation was located near the center of the one-story section of the building.

Originally the process presented little or no hazard because the grease was heated by steam to make it flow readily. A short time prior to the fire, however, the process was changed and instead of being heated the grease was dissolved in over three times its weight of naphtha to make a thin, easy flowing mixture. This change to naphtha introduced a specific hazard, but the plant management felt that it was fairly well safeguarded by the ventilation provided and by a good supply of foam extinguishers.

Story of the Fire.

Early in the morning of the fire employees filled the tank with the thinned grease mixture and operated the spray pump a few minutes to make sure that the nozzles were clear, but did not start the ventilating fans. Naphtha vapors accumulated and two hours later, at five o'clock, when the foreman pressed the switch button to start the tank agitator pump, there was a flash in and around the booth. It seems apparent that the flammable vapors were ignited by an electric spark from the switch. Almost immediately the contents of the tank caught fire and an intense blaze was soon in progress.

It is estimated that about 175 sprinklers supplied by a 100,000-gallon gravity tank, both in the booth and under the sawtooth roof, opened within a

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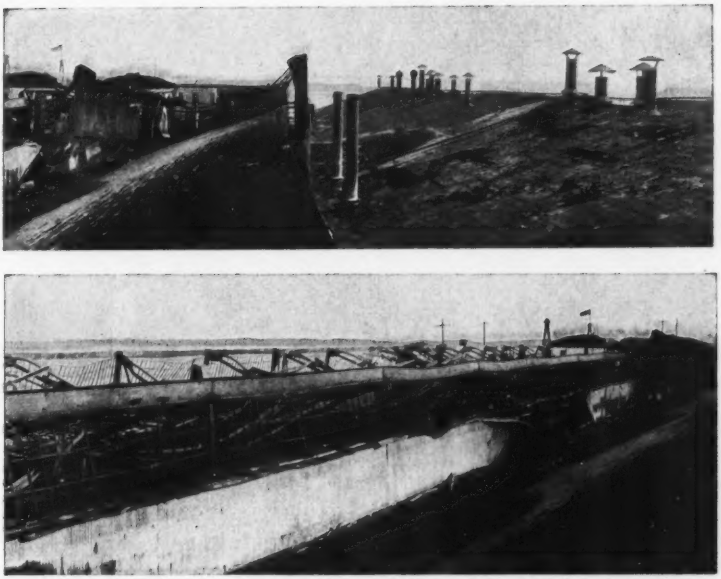
This report has been extracted from the *Factory Mutual Record.*

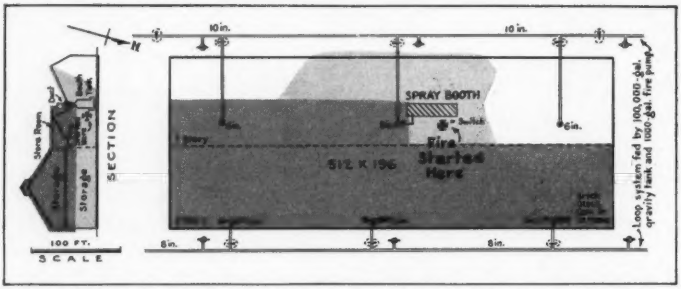


Roof of Ford Motor Plant building at Chester, Pa., showing destruction of entire section and second story after sprinkler tank was exhausted. The fire spread to the combustible roofing through the vent pipes shown in center of upper picture.

few minutes. Employees promptly sounded the plant and public fire alarms and then used six 40-gallon foam extinguishers, directing the streams into each end of the booth. Aided by the sprinklers, they had the fire practically under control in about fifteen minutes, except for a few small flames at the peak of the sawtooth out of reach of sprinkler water.

On receipt of the alarm, the plant engineer started the 1000-gallon fire pump, after first putting into operation the booster pump which supplies suction from the near-by river. He could not get the pressure above the tank pressure of 45 pounds, which indicated that the sprinklers were taking not only all the pump could supply, but were drawing upon the tank as well.

By this time the first fire department pumper arrived, followed soon after by four others. They connected to the yard hydrants and supplying one or more streams each, they took water away from the fire pump and tank. Although the delivery of the fire pump had been increased to 1400 g.p.m. by starting another suction booster pump, the tank was emptied in about thirty minutes. The sprinklers were discharging about 3500 g.p.m. and when the tank gave out, the draft of the pumpers reduced the pressure in the yard system to below zero gauge, so that some of them actually lost suction. There was then no water left for the sprinklers.



Dark shading shows extent of complete destruction of roof, second floor, and contents; lighter shading, of less severe damage.

At this time the fire was thought to be practically extinguished, but someone suddenly noticed that fire was starting to spread on the outside of the pitched roof of the two-story section. It was feeding on the asphalt and felt roof covering, which was not protected by gravel or slate surfacing. One of the two vent pipes from the booth which extended through the roof was but five feet away from the roof of a small storeroom which extended above the sawtooth. The burning grease deposits in this vent pipe spread the fire to the asphalt roof covering, and fanned by a moderate wind, it spread unchecked up over the outside of the pitched roof and quickly worked through monitor windows into the second story.

When the firemen found the fire springing up again, spreading rapidly and their pumpers without an adequate water supply, they disconnected their suctions from the yard hydrants, moved to the river bank, and drafted from the river. Had this source of water supply been used in the first place the fire could have been kept under control and much of the loss prevented.

The shifting of the pumpers from one place to another took appreciable time and meanwhile effective hose streams could not be supplied from the fire pump through the yard hydrants because the sprinklers, many more of which had opened, were bleeding the system. This was a situation where it would have been advisable to close the sprinkler valves, but this was impossible because they were located in pits which had filled with water. In this interval the only hose stream available was from a pumper at a distant street hydrant, and since the sprinklers were now without water, the fire spread rapidly under the joisted roof.

The relocated pumpers finally got ten or twelve streams in service again. The firemen had great difficulty in fighting the fire with hose streams in the large high roof area. Before the fire was brought under control at ten o'clock, it completely destroyed the entire roof and two-thirds of the floor of the two-story section, burned away part of the adjoining sawtooth roof, destroyed the entire storage in the second story, and caused a wet-down of most of the storage on the first floor.

Airplane Fire Record.

Since the publication of the Airplane Fire Record, QUARTERLY, January 1930, Vol. 23 No. 3, one hundred and seventy-six fires have been reported to the N.F.P.A. Department of Fire Record. These added to the fires covered by the previous record make a total of 303 reports of airplane fires recorded in the fire record files. The analysis which follows is based on the experience recorded by these fires which, in addition to the destruction of the planes, exacted a toll of 378 lives.

This fire record includes all fires involving airplanes, except those occurring while planes are in hangars. Due to the special hazards involved, fires in airplane hangars have not been included in this record even though the presence of airplanes may have been a factor in the fire. A detailed fire record of airplane hangars was published in the QUARTERLY, April 1930, Vol. 23, No. 4.

A clipping service on airplane fires has been employed for the past three years and is responsible for a large proportion of the available fire reports. The newspaper reports, while manifestly incomplete in many important details and no doubt frequently inaccurate, are practically the only records available. Care having been used in analyzing them, it is considered that they form a fairly satisfactory basis for the conclusions drawn herein. Because the planes involved were frequently completely destroyed, further investigation would probably not bring forth any more reliable information. Thirty-three fires in aircraft occurring in foreign countries are not included in this record because it was felt that their inclusion might to some extent distort the picture of flying conditions in America.

Classification by Types of Airplane.

Fires have been classified with thought of grouping together types of planes which would be subject to approximately the same hazards of service. Classifications used in the 1930 Airplane Fire Record appear to be the most satisfactory and have been retained.

EXPERIMENTAL PLANES. In this group were put experimental planes; new types; planes used in endurance, long distance, altitude and other test flights; racing planes and those used in exhibitions or contests.

MILITARY PLANES. In this group were put 29 army and 10 navy planes. Five of the army planes were being flown by reserve officers and the others were in regular army service.

AIR MAIL AND COMMERCIAL PLANES. Includes air mail planes and planes of commercial lines operating on a regular schedule. While it is difficult to separate these two types of service because mail and passengers are frequently

International.

This military training plane caught fire due to a broken gasoline line while at an altitude of 200 feet. The plane was landed in a field in time for both occupants to escape.

carried in the same plane it was found that of the 54 fires in this class one third, or eighteen, occurred in strictly mail planes.

PRIVATE PLANES. This was the class having the largest number of fires. It was often impossible to determine whether a plane was strictly private or whether it had a semi-public service character. Of the 172 planes in this group 62 were, as far as could be determined, strictly private or used for giving public rides. Sixty-one were known to have been used for public rides or taxi service. Thirty-nine were being used for training purposes and were largely flown by student pilots. Ten fires occurred in planes of miscellaneous service, such as manufacturers' demonstrators, rental planes or forest patrol work.

In addition to these classifications it is necessary to consider three distinct types of fires. The first includes all fires starting in the air. The second class includes all fires starting on the ground exclusive of airplane fires occurring in hangars. The third class consists of fires which follow crashes. Crash fires are the most numerous and the most disastrous to human life.

Fires in Airplanes.

Class	Crash Fires	Fires in Air	Ground Fires	Total
Experimental	19	10	9	38
Military	17	17	5	39
Air Mail and Commercial	35	14	5	54
Private	110	40	22	172
Total	181	81	41	303

Some light as to causes of airplane fires may be derived from a table showing the part of the plane in which fires originated. This includes all fires

exclusive of crash fires. Detailed tables of causes are given under the separate sections which follow.

Origin of Fires.

	No. Fires
Motor compartment	26
Fabric	19
Passenger cockpit	7
Gasoline tank	5
Wing	3
Mail compartment	2
No data	60
Total	122

Due to the nature of the available reports it was impossible to compile any detailed loss statistics. The following table indicates, as might be expected, that once an airplane is ablaze a total loss usually results.

	Crash Fires	Fires in Air	Ground Fires	Total
Planes destroyed	180	69	31*	280
Planes badly damaged	1	3	5	9
Planes slightly damaged	0	9	5	14
Total	181	81	41	303

*In several instances ground fires destroyed more than one plane. Total number of planes destroyed in ground fires was 36.

Fires Starting in the Air.

A total of 81 airplane fires occurred while planes were in the air. These fires resulted in total destruction of the plane in 69 instances and in three other instances planes were severely damaged. In nine cases the fire was extinguished with small loss either in the air or after a forced landing.

Fires Starting in Air.

	Experimental Planes	Military Planes	Commercial Planes	Private Planes	Total
Forced landing, plane damaged	1	2	4	2	9
Forced down, plane destroyed	6	5	4	24	39
Parachute used, plane abandoned	0	9	3	2	14
"Explosion" in air	2	1	1	10	14
Fire extinguished in air	1	0	1	3	5
Total	10	17	13	41	81

As might be expected, the greatest single known cause of fires in the air was due to the hazard incidental to the use of gasoline. There were nine instances of fuel lines breaking or leaking, due in part to the stresses and vibrations to which they were subjected, as well as to the corrosive effect of the high test fuel used. Five fires were due to the spilling of gasoline from the fuel tanks. Once gasoline escapes from tanks or piping, hot motors and exhaust pipes offer ready ignition. It is reasonable to assume in at least a portion of the fires reported as "explosion in air" that the fire or explosion was due to the ignition of escaping gasoline. The following table shows the causes of airplane fires originating in the air.

International.

All-metal transport plane after a crash shortly after taking off from the Oklahoma City airport on December 23, 1931. One of the pilots was thrown clear of the wreck and the other was dragged through the flames by an eyewitness of the accident.

Causes of Fires.

	No. Fires
Broken or leaky fuel line	9
Gasoline spilled on hot motor	5
"Explosion" in air, no data	5
Backfire or exhaust	4
Motor ignited, no detailed data	3
Lightning	2
Smoking and matches	2
Miscellaneous	5
Open heaters — 1	
Smoke bomb — 1	
Defective wiring — 1	
Structural failure — 1	
Defective heater insulation — 1	
Unknown	46
Total	81

Brief summaries of typical fires are given below to illustrate the causes of fires in the air.

Typical Fires in the Air.

FAIRFIELD, CONN., MARCH 17, 1930. A broken gasoline line is said to have been responsible for a fire which occurred while a seaplane was attempting to set a speed record while flying over Long Island Sound. When the plane ignited the pilot brought the craft down in shallow water near shore and jumped from the plane uninjured. The craft was destroyed. (H-30052.)

AYER, MASS., MAY 28, 1930. Combustible parts of an airplane were ignited by backfire just as it left the ground. The pilot nosed the plane down from a height of 150 feet. Flames drove him from the craft when about thirty feet from the ground, but he escaped injury. The plane was destroyed. (H-30077.)

LOUISVILLE, KY., JUNE 21, 1930. While stunting over an airport the oil line of a private plane gave way and oil was spilled on the engine and ignited. Quick action on the part of the pilot when the fire broke out saved the craft. By opening the sides of

the engine and taking a long side dive, which brought him nearly to the ground, the pilot extinguished the fire and saved the plane. (H-30071.)

LATHAMS, N. Y., MAY 20, 1931. Fire occurred while an airplane containing three persons was at an altitude of 1000 feet. The fire is thought to have been due to a leaky gasoline feed line. The pilot managed to land the plane before flames reached the fuel tank. The plane was totally destroyed. Neither the pilot nor the two passengers were injured. (H-32655.)

RANTOUL, ILL., JULY 2, 1931. Fire occurred in an army plane over Chanute Field when the fabric near the tail of the plane was ignited by the hot exhaust pipe. The pilot successfully landed the craft, but was severely burned before he could free himself. His mechanic was also severely burned and the plane was totally destroyed. (H-32666.)

MEMPHIS, TENN., JULY 10, 1931. Shortly after leaving the airport a pilot discovered a fire in the rear of his plane. Fabric was burned from the plane, but fortunately the pilot escaped with minor burns. A cigarette is believed to have caused the fire. (H-32667.)

BALTIMORE, MD., OCTOBER 18, 1931. While at an altitude of 200 feet the gasoline line of a plane broke and gasoline was ignited by the hot engine. The pilot was able to land the plane and with his passenger escaped before it was destroyed. (H-33367.)

Loss of Life in Fires Starting in Air.

The following table indicates the loss of life in fires occurring in the air.

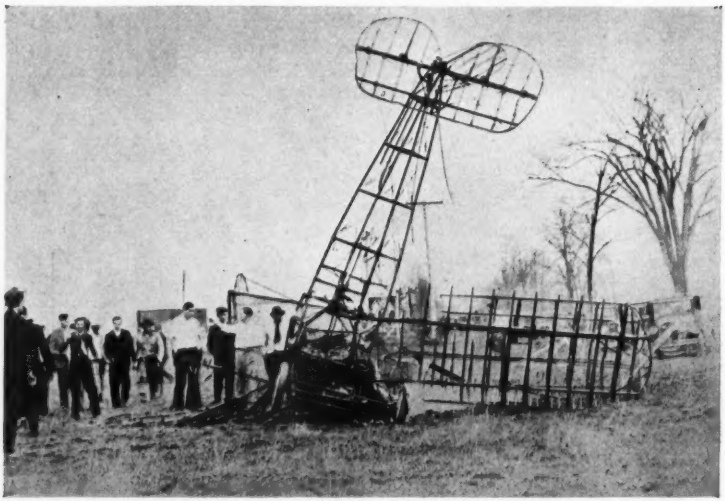
Class	No. Fires	No. Fatal Fires	No. Persons Involved	No. Killed	Per Cent Persons Killed to Persons Involved
Experimental	10	4	16	7	43.8
Military	17	5	29	7	24.2
Air Mail and Commercial	14	3	55	6	10.9
Private	40	24	81	52	64.3
Total	81	36	181	72	39.8

From the foregoing table it will readily be seen that the percentage of loss of life was far greater for private planes than for either the military or commercial classes. The percentage of loss of life in planes used for experimental purposes was probably high, due to the small number of persons involved and the hazards incidental to the use of the plane for experimental work.

Commercial air lines have made a remarkable record for safe operation. Good construction, constant inspection and supervision, trained crews, adequate landing fields, and the provision for fire protection equipment are among the factors in keeping down the loss of life in commercial planes. With commercial or military planes in the hands of skilled pilots the chances of a *safe* forced landing are far greater than with the average privately owned plane, and the fire record includes several instances where commercial pilots safely landed burning planes carrying up to twenty-one passengers.

Typical Loss of Life Fires in the Air.

JENA, LA., FEBRUARY 14, 1930. Two passengers were killed and the pilot was badly burned when an airplane caught fire in the air. The flaming craft fell into a baseball park several miles from the town. (H-30048.)



Three men were electrocuted when this airplane fell into high tension wires. One, a passenger, lost his life by direct contact with the charged metal frame of the plane. The others received fatal shocks as a result of using a soda-acid extinguisher on the burning ruins of the plane.

TULSA, OKLA., APRIL 3, 1930. Two student pilots, lacking parachutes, jumped to their deaths from a height of 3000 feet as fire caused by a cigarette ignited the fuselage. Strangely enough after the men jumped the plane made almost a perfect landing and burned on the ground. (H-30055.)

SCOTT'S BLUFF, NEB., MAY 31, 1931. Two men were killed when thrown from their airplane, which caught fire in the air. Both bodies landed in a downtown street and the plane fell on the same spot, burning the bodies beyond recognition. (H-30074.)

OAKLAND, CALIF., AUGUST 12, 1930. Shortly after taking off, an explosion ignited a small biplane. The craft fell to the ground in flames and both the pilot and passenger were burned beyond recognition. (H-30082.)

SHEBOYGAN, WIS., AUGUST 23, 1930. Three men were killed when the airplane in which they were riding caught fire in the air. Flames were seen to shoot from the motor shortly after the plane left the airport. An explosion occurred as the pilot attempted to bank at an altitude of 1000 feet. The three occupants were killed when the plane fell. (H-30133.)

DETROIT, MICH., NOVEMBER 24, 1930. Two men were killed when a tri-motor experimental airplane caught fire in the air after a short flight. The pilot brought the blazing plane down in the center of the field at the airport. As the plane landed it turned over and was enveloped in flames, so that the rescue of the two men was impossible. (H-30507.)

PORTERVILLE, CAL., MARCH 16, 1931. Fire occurred shortly after an airplane took off from airport. The plane burst into flames at an altitude of 300 feet, when the pilot banked the plane sharply. The two occupants were burned to death. (H-31331.)

BRANDON, MAN., APRIL 29, 1931. Two men were killed when an airplane caught fire above the Brandon airport. The gasoline tank exploded as a result of the fire. (H-32498.)

OAKLAND, CAL., SEPTEMBER 16, 1931. A passenger mail plane carrying four men caught fire shortly after taking off from the Oakland airport and plunged into San Francisco Bay. The pilot attempted to return to the airport when the fire was discovered, but flames rapidly enveloped the airplane, which crashed to the water and sank. The victims were trapped in the cabin. (H-32813.)

WALDEN, N. Y., OCTOBER 11, 1931. An aviator was taking two boys for a ride when fire broke out in the plane. The blazing ship fell at the airport and all three persons lost their lives. (H-33365.)

Use of Parachutes.

The use of parachutes is one method of reducing loss of life from fires, which this record has demonstrated to be successful. In military flying the use of parachutes by pilots and passengers is compulsory and has held the loss of life in military planes to a very low figure. It appears reasonable from this experience that the high loss of life in the case of flying privately owned craft might be materially reduced if parachutes were universally used.

Where there are more than one or two passengers it is less easy to use parachutes. In multi-passenger commercial planes where the passengers are not likely to be familiar with the operation of parachutes or actually distrustful of them, their value has been questioned. Operators of passenger air lines reason that greater safety for the passengers is obtained by trusting to the skill of the pilot in being able to land the plane safely in an emergency. This has been done in several of the fires included in this record. With proper instruction in their use and their increasing reliability, it may prove practicable in the future to require all passengers even in commercial planes to wear parachutes.

Class of Airplane	Total No. of Fires	No. of Fires Parachutes Available	Lives Saved by Parachutes
Experimental	10	2	0
Military	17	17	12
Air Mail and Commercial	14	3	4
Private	40	5	3
Total	81	27	19

Two factors limit the effectiveness of parachutes. They cannot be used at low altitudes and they necessitate the abandonment of the plane, which means an inevitable crash and possible damage to buildings or injury to persons. These factors are, however, not of as great importance as may at first appear because when a plane takes fire at low altitudes there is usually time to land it safely. When it takes fire at high altitudes the use of parachutes may offer the only chance for the safety of the passengers. Also, the chances of a plane falling out of control and doing damage are relatively slight, as most flying is done over open country. A number of typical fire reports illustrating the successful use of parachutes follow.

Typical Fires Where Parachutes Were Used.

CHICAGO, ILL., AUGUST 10, 1930. A student flier had cut off his motor in order to land, when backfire ignited combustible portions of the plane. He was forced to jump with a parachute from a height of 1500 feet in order to save his life. The burning plane landed in a field and was completely destroyed. (H-30083.)

DAYTON, OHIO, OCTOBER 1, 1930. An army airplane caught fire while flying upside down during a test flight. The pilot made an unsuccessful attempt to beat out the fire with his hands, but was unsuccessful and jumped to safety. He received minor burns. The plane landed in a corn field. (H-30138.)

DETROIT, MICH., APRIL 29, 1931. An army airplane in which a new motor had just been installed caught fire in the air. The pilot was severely burned before he could release the safety catch of his parachute, but succeeded in doing so and jumped. He also suffered injuries in landing, for his parachute did not open until he was but a few hundred feet from the ground and the speed of his fall was not entirely checked. (H-32499.)

CLEVELAND, OHIO, SEPTEMBER 6, 1931. While making a test flight in preparation for coming air races a gasoline line broke and the speeding plane was enveloped in flames, as the escaping gasoline ignited from the hot exhaust. The pilot, although seriously burned, escaped by jumping with a parachute. The plane fell to the ground and was destroyed. (H-32866.)

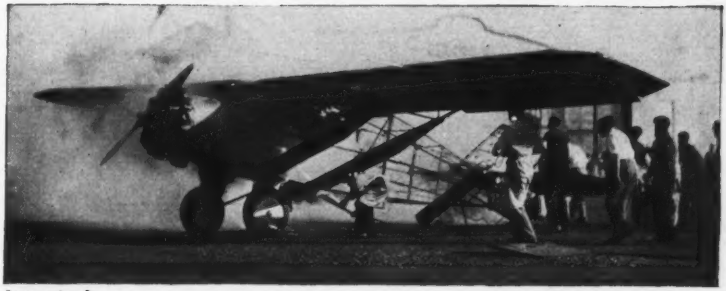
CHICOPEE FALLS, MASS., OCTOBER 30, 1931. A few minutes after taking off from the airport a plane containing two pilots burst into flames. Both pilots made use of their parachutes and jumped to safety. The plane crashed in a tobacco field and was destroyed. That both pilots wore parachutes was an unusual circumstance, as they more often than otherwise discard these safeguards on short flights. (H-33520.)

Fires Starting on the Ground.

Of the thirty-three fires of known origin starting on the ground, fourteen were attributed to backfire or the ignition of fabric parts by sparks or flames from the exhaust. In a considerable number of instances backfire occurred when starting a cold motor. Flammable fabric was also a factor in other fires due to use of welding equipment or careless deposit of matches or cigarettes. Detailed causes of ground fires are given in the table which follows.

Cause		No. of Fires
Backfire or exhaust		14
Smoking and matches		4
Incendiary		4
Welding operations		3
Collision while taxiing		3
Miscellaneous		5
Grass fire	1	
Washing plane with gasoline	1	
Static electricity, while tank was being filled	1	
Structural failure	1	
Broken fuel line	1	
Unknown		8
Total		41

As might be expected, the number of fatal airplane fires occurring on the ground was small, for it was usually possible for occupants, if any, to escape



International.

Fire in the plane in which Russell Boardman planned to cross the Atlantic was promptly extinguished by the personnel of the Boston Airport on September 4, 1930. A number of wheeled carbon dioxide units were rushed from near-by hangars; soda-acid and carbon tetrachloride extinguishers were also used.

without difficulty. Three ground accidents resulted in the loss of five lives. Two of these were due to crashes and the other to the failure of the running gear while speeding down the field for a take off.

Typical Fires Occurring on the Ground.

ROOSEVELT FIELD, N. Y., SEPTEMBER 21, 1926. Two men were killed and two escaped when the running gear of an airplane in which they were taking off failed, and the plane crashed into a gully and burned. (H-23820.)

NEW ORLEANS, LA., AUGUST 23, 1929. Fire occurred at the airport when a passenger plane taxied in front of a mail plane which was making a take off. The pilot of the passenger plane was burned to death. (H-28030.)

PENSACOLA, FLA., MARCH 25, 1929. An airplane piloted by a student at the Naval Air Station telescoped another plane standing on the ground. Both immediately caught fire and blazing gasoline was spread all around. The two men in the plane which was struck were burned to death and the pilot of the plane attempting the take off was seriously burned. (H-27163.)

LONG BEACH, CAL., JANUARY 31, 1930. Two naval officers were severely burned when their airplane was wrecked in an attempt to avoid a collision at the municipal airport. While speeding down the runway for a take off, a civilian plane cut across their path. The naval pilot banked sharply, causing one wing to strike a hangar. The gasoline tanks were ruptured and the naval plane burst into flames and was destroyed. Attendants at the field dragged the officers to safety. (H-30035.)

CLEVELAND, OHIO, JULY 19, 1930. Just after returning from an exhibition flight a plane, which had recently received a $100,000 award as the world's safest airplane, was destroyed by fire. The plane had passed numerous strict requirements for safe flying and was considered nearly foolproof. This, however, did not prevent its rapid destruction when sparks from the motor igniting dry grass on the field started a fire which communicated to the plane. (H-30086.)

BOSTON, MASS., SEPTEMBER 4, 1930. Fire occurred in a plane at the local airport while an auxiliary gasoline tank was being filled. The fire is thought to have been due to static electricity. Flames enveloped the fuselage and right wing and tail service. A fire alarm was promptly given and employees responded with fire extinguishers of various types and extinguished the fire. The loss was estimated at $2,500 out of a value in excess of $18,000. (H-30152.)

International.

As this autogyro was run out of its hangar at the National Air Races in Cleveland, September 7, 1931, backfire of the motor ignited the wing fabric of the plane. The pilot and a passenger leaped to safety. The plane was badly damaged in spite of the use of first aid fire extinguishing appliances by hangar employees.

COLUMBUS, OHIO, NOVEMBER 2, 1930. An airplane was being taxied across the air field when the gasoline line broke, allowing gasoline to flow on the hot motor and ignite. The pilot escaped, but the plane was destroyed. (H-31013.)

ROCKFORD, ILL., JULY 23, 1931. As a monoplane was about to take off from the airport, motor backfired and ignited the plane. The pilot brought the plane to a stop and leaped to safety. (H-32673.)

CLEVELAND, OHIO, SEPTEMBER 7, 1931. As an autogyro taxied out onto the airport field for a take off, backfire caused a fire which destroyed the plane. The pilot and passenger jumped to safety. (H-32880.)

LOUISVILLE, KY., SEPTEMBER 9, 1931. While an airport employee was attempting to start an airplane, backfire ignited the fabric of the plane. The pilot was severely burned about the face and hands before he could escape, and the plane was badly damaged before the fire was extinguished. (H-32869.)

LOUISVILLE, KY., OCTOBER 26, 1931. A woman pilot narrowly escaped injury when her monoplane burst into flames as she was warming the motor preparatory to taking off. Vibration is thought to have released a dump valve and allowed gasoline to escape and ignite. (H-31767.)

Crash Fires.

As noted in the previous airplane fire record (QUARTERLY, January 1930, Vol. 23, No. 3, page 263), the reports of crash fires have proved very unsatisfactory from a fire record viewpoint. Available data as to the factors causing the crash were very meagre or merely a speculation. In almost every case reported the plane was destroyed and in most instances the occupants fatally burned or killed by the crash or both.

Comparatively little definite information is available on the factors directly responsible for the crashes which resulted in fire. Obviously, motor failure forced the plane down in most cases, but data as to whether the failure

International.

Two army aviators lost their lives when their plane crashed in flames at Valbuena Field, Mexico City, February 2, 1931. One man was instantly burned to death. Spectators dragged the other from the blazing wreckage, but he did not long survive his companion.

was mechanical or due to fuel shortage or other reasons were not given. Many fires were undoubtedly the result of the rupturing of the fuel tanks following the crash, and ignition came generally through contact of gasoline with hot exhaust pipes and motor or by sparks from ignition systems or struck by metal parts in contact with other metal members. Six crash fires occurred when plane struck high tension wires while taking off or landing.

The following table gives the causes of crashes and the subsequent fire with as much detail as was obtainable from the reports.

Cause of Crash	No. of Fires
Due to motor trouble	28
Due to fog or bad weather and air conditions	22
Crashed during regular landing (lost flying speed, wind unfavorable, etc.)	19
Crashed in take off (collisions with other planes, trees, etc.)	18
Crashed shortly after take off (motor trouble, failed to gain altitude, etc.)	15
Inexperienced operator	10
Stunting or racing	8
Crashed while on test flight	5
Structural or mechanical failure	3
Night flying	2
Fuel of endurance plane exhausted	2
Passenger interfered with controls	2
Overload of gasoline	1
Pilot overcome by carbon monoxide	1
No data	46
Total	181

Due to the character of the reports it was difficult to definitely ascertain whether loss of life was due to the fire or to the crash. Instances where loss

of life could be definitely charged to the crash have not been included in this record. On the other hand it was obvious in many cases that, but for the fire following, the crashed occupants might have been saved even though seriously injured. In twenty-four fires, one or more occupants escaped safely, although others in the same plane were burned to death or killed. Of the 181 crash fires recorded, all but 42 had fatal results.

Among the stories of typical crash fires which follow are instances where falling airplanes struck buildings. While in some of these cases the fire originated in the air, these fires are included here because the damage to the buildings was incidental to the crash, rather than to the origin of the airplane fire. This feature of the airplane fire problem threatens to become a potential hazard to home owners everywhere, particularly in the immediate vicinity of airports.

The table below summarizes the loss of life record following crashes. This, together with brief accounts of typical crash fires, will be allowed to speak for itself, for in the case of crash fires the blaze follows the crash and there is probably little that a fire protectionist can do in such cases.

Loss of Life in Crash Fires.

Class	No. of Fires	No. of Fatal Fires	No. Fatal Fires Where One or More Escaped	Total No. Occupants Involved	Total Killed by Fire	Per Cent Killed	Fatalities per Fire
Experimental	19	9	0	28	14	50.0	.7
Military	17	14	1	29	23	79.4	1.3
Air Mail and Commercial	35	23	3	110	77	70.0	2.2
Private	110	93	20	238	187	78.6	1.7
Total	181	139	24	405	301	74.3	1.7

It should be borne in mind that the foregoing table may fail to include a number of crash fires where no one was injured and hence were not reported. This fact might somewhat alter the figures given for "Per Cent Killed" and "Fatalities per Fire." However, it is felt that the figures given measure to some degree, at least, the relative hazard of military, commercial and private flying. It will be readily recognized that the large number of fatalities ascribed to commercial planes is due to the number of passengers carried rather than indicative of a greater life hazard for the class.

Typical Crash Fires.

OAKLAND, CALIF., SEPTEMBER 14, 1929. An airplane which caught fire in the air fell upon a dwelling house which, with an adjoining building, caught fire and was seriously damaged. The two occupants of the plane were burned to death. (H-28257.)

CARLE PLACE, N. Y., NOVEMBER 27, 1929. A large passenger airplane failed to gain sufficient altitude after taking off and crashed into four dwellings in a crossroad settlement half a mile from the airport. The first two houses struck escaped with damaged

International.

When an airplane struck the roof of a house on Staten Island, N. Y., it burst into flames. The pilot was thrown out and badly injured, while a passenger in the plane was burned to death. An elderly woman in the yard adjacent to the house was sprayed with flaming gasoline and fatally burned. Two houses were destroyed.

chimneys and roofs. The third building was wrecked and burned, as the gasoline tank of the plane exploded. A fourth dwelling was seriously damaged. (H-28472.)

SANTA MONICA, CALIF., JANUARY 2, 1930. Ten men lost their lives when two planes used in producing a motion picture collided in the air and burst into flames as the gasoline tanks ignited. (H-30040.)

KANSAS CITY, KANS., JANUARY 27, 1930. A commercial plane carrying five persons crashed from a height of 400 feet while preparing to land at the airport. Flames immediately followed the crash and all of the occupants were burned to death. (H-30037.)

YPSILANTI, MICH., APRIL 13, 1930. Three men lost their lives when an airplane became entangled with the wires of an electric power line as it was about to land at an airport. The metal parts of the plane completed the circuit between the wires and the earth and became charged to a potential of 4800 volts. The pilot saved his life by leaping from the plane, but his passenger received a fatal shock. The plane ignited and a mechanic at the airport directed a stream from a fire extinguisher upon the flames. The liquid from the extinguisher served as a conductor and the mechanic was instantly killed. A bystander also received a fatal shock while attempting to save the mechanic. (H-30081.)

COLUMBUS, OHIO, MARCH 29, 1931. A disabled airplane crashed into a street after tearing away the corner of the roof of a house. One wing of the plane was ignited by contact with high tension wires. Fire was confined to the wing of the plane. (H-31332.)

MT. CLEMENS, MICH., JUNE 25, 1931. An airplane crashed and burned at the rear of a farmhouse. The walls of the building against which the plane fell were ignited, but the fire was extinguished by the fire department before serious damage resulted. (H-32662.)

International.

The wreckage of the Western Canada Airway Mail plane which crashed and burned on September 25, 1930, at Southesk, Alberta, causing the death of the three occupants.

CHICAGO, ILL., JULY 12, 1931. Two pilots were burned to death when a large monoplane crashed from a height of 700 feet near the municipal airport. Gasoline tanks in the wings burst into flames and the two men were trapped in the cabin of the flaming plane.

JONESBORO, ARK., JULY 12, 1931. A falling airplane struck the roof of a house and then crashed to the ground and burst into flames. Two sixteen-year-old girl passengers in the plane were trapped and burned to death, while the pilot was severely burned. The fire department confined the fire to the plane by use of hose streams. (H-32669.)

STATEN ISLAND, N. Y., SEPTEMBER 21, 1931. An airplane falling in flames struck the roof of a dwelling. The impact caused the explosion of the plane's gasoline tank, scattering the blazing fuel about. An elderly woman in the yard of the house was a victim of the blazing gasoline. One occupant of the plane was also fatally burned, but the pilot escaped with minor injuries. Fire spread to an adjoining dwelling and both buildings were practically destroyed before the fire department brought the blaze under control. (H-32864.)

NORTH BEND, WASH., NOVEMBER 1, 1931. Five persons were burned to death when their airplane was forced down by stormy weather. When the pilot attempted to land on a highway the plane immediately caught fire and was destroyed. (H-33363.)

ARLINGTON, VA., NOVEMBER 7, 1931. Three men were killed when their plane fell into a crowded highway and burst into flames shortly after taking off from the airport. The plane failed to gain more than 100 feet altitude after taking off and the motor stalled when the pilot attempted to clear some wires near the field. (H-33521.)

Use of Fire Extinguishing Equipment.

Little detailed information is available as to the use of fire extinguishing equipment on airplane fires. Numerous reports state that the pilot was burned in an attempt to extinguish the fire or indicate that an extinguisher was used, but beyond this bare statement of fact, details are lacking. It is apparent, however, from a number of reports, that when first aid equipment was available it was used with more effectiveness than might be anticipated where conditions are so favorable for an intense quick blaze.

Brief summaries follow of typical cases where fire equipment has been used. These have been included, not so much with the thought of proving the effectiveness of any particular type of extinguishing device, as to indicate the value of such devices as part of the essential equipment of all airplanes. At the same time these summaries also give ample proof of their importance as a factor in saving life.

ATLANTIC OCEAN, SEPTEMBER, 1928. Fire occurred during a trans-Atlantic flight when a fuel line broke and gasoline was ignited by the hot motor. The plane was flying at an altitude of 1500 feet at the time. The fire was extinguished by carbon tetrachloride equipment (probably automatic), but not before the metal engine supports and carburetor were badly damaged, the cowling burned away and paint blistered. But for this equipment the plane would have been destroyed and the pilot killed. (H-30091.)

LOS ANGELES, CAL., AUGUST 28, 1928. Fire occurred with the premature explosion of a smoke bomb secreted in the plane for publicity purposes. Upholstery was ignited in several places. The prompt use of a carbon tetrachloride extinguisher extinguished the fire and saved the lives of the four occupants of the plane. (H-30092.)

MAUMEE BAY, OHIO, JANUARY 16, 1929. A fire occurred in an airplane from the ignition of mail sacks, which had been placed on open heaters. The fire was discovered while the plane was 2000 feet in the air. The pilot and his mechanic tried to extinguish the flames with "chemical throwers," but were not successful. When that failed, the pilot turned the plane back toward land and crashed in a field. He was severely burned and had to be rescued from the cockpit. (H-27042.)

MT. CLEMENS, MICH., NOVEMBER 14, 1929. With his plane ablaze a military pilot brought his ship to ground safely from an altitude of 1000 feet, leaped from the cockpit and put out the fire with an extinguisher. (H-28360.)

PONTIAC, MICH., AUGUST 18, 1930. While four passengers, including a woman, fought a fire with chemical extinguishers the pilot landed a burning cabin plane from a height of 3000 feet. The passengers were successful in keeping the fire from the cabin while the plane was being brought down, but shortly after they escaped the airplane was wrecked by a gasoline explosion. (H-30149.)

ROSEBURG, ORE., MARCH 2, 1931. Fire occurred in the mail compartment of an air transport plane carrying a pilot and three passengers. As smoke filled the cabin one of the passengers grabbed a fire extinguisher and fought the fire while the pilot brought the ship down. In landing the plane struck some brush and the lower wings were demolished, but the occupants escaped with minor injuries. After landing, the pilot completely extinguished the fire and saved the mail, which, although somewhat scorched, was not seriously damaged. (H-31291)

CLEVELAND, OHIO, MAY 14, 1931. An explosion occurred in the rear of an amphibian passenger plane shortly after it took off for a trip across Lake Erie. Flames began to sputter from the motor immediately following the explosion, but were quickly checked when the co-pilot climbed through an opening in the motor compartment and used a fire extinguisher. The crippled craft was brought down on the water and towed back to the dock. (H-32654)

ABERDEEN, MD., MAY 15, 1931. A tri-motored Richmond-New York transport plane with 21 persons aboard caught fire while 1500 feet in the air due to defective insulation of a heater pipe. While the pilot safely landed the burning plane in a field, the co-pilot by use of fire extinguishers prevented the blaze from reaching the motors. All of the occupants were able to escape, and soldiers at barracks near by completely extinguished the fire. (H-32510)

An Unusual Fire Due To Lightning.

Report by Underwriters Service Association,
(Member N.F.P.A.)

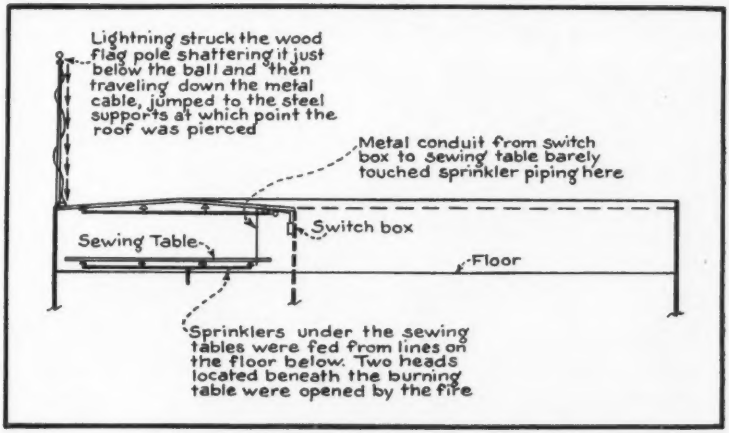
An unusual fire attributable to lightning occurred early in the morning of July 15, 1931, in the plant of the Associated Apparel Industries, Inc., on the outskirts of Belvidere, Illinois. The fire is of particular interest in that it is the only instance recorded in the fire record files of the N.F.P.A. Department of Fire Record, where lightning entered a building through the sprinkler system.

The building involved in the fire was a small two-story and basement brick structure of mill construction occupied for the manufacture of corsets and ladies' underwear. At the center of the front of the roof over the main entrance to the building was a wooden flagpole set in a metal frame. A copper cable wound down the pole from the top. Lightning struck the top of the flagpole, from whence it passed through the roof of the building and was conducted through the piping of the sprinkler system.

Story of the Fire.

The fire was discovered shortly after midnight by the watchman who had just completed his round and was on the main floor of the building. From the noise of the crash he was convinced that the building had been struck. A second bolt of lightning followed immediately, apparently striking the same spot. Following the second crash the watchman heard water running on the second floor and rushed up the stairway to investigate. Smoke, which by this time filled the upper story, prevented him from seeing very much. The heat was intense and he returned downstairs, where he waited a few minutes until he thought sufficient time had elapsed for the sprinklers to extinguish whatever fire there might have been. He then shut off the main switch in the building controlling the power and light and finally shut off the post valve controlling the sprinklers. When he went up to the second floor again he could still see sparks and evidences of a smouldering fire across the room through the smoke, so he immediately returned to the first floor and opened the sprinkler control valve. He states that he had no idea of the number of sprinkler heads operating.

An attempt was then made by the watchman to reach the fire department by telephone. This was unsuccessful due to the fact that the line was out of service and a near-by neighbor volunteered to notify the fire department by driving to town in his automobile. The watchman allowed the sprinklers to remain in operation until the arrival of the fire department, when they were again shut off. It was then discovered that a large number of sprinklers had operated and that the fire was completely extinguished.


Lightning struck the wood flag pole shattering it just below the ball and then traveling down the metal cable, jumped to the steel supports at which point the roof was pierced
Metal conduit from switch box to sewing table barely touched sprinkler piping here
Switch box
Sewing Table
Floor
Sprinklers under the sewing tables were fed from lines on the floor below. Two heads located beneath the burning table were opened by the fire

Course of Lightning and Operation of Sprinklers.

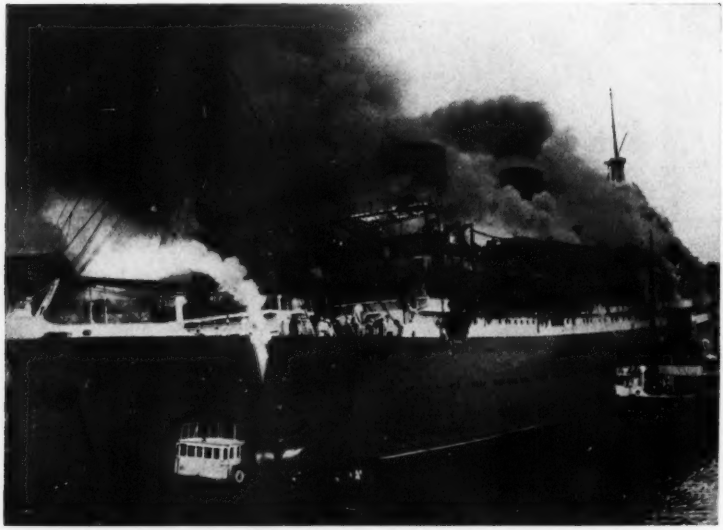
It is evident that lightning first struck the top of the wooden flagpole, shattering a wooden collar at the base of the ball, and then traveling down a copper cable to the base of the pole, which was held in position by steel braces attached to the roof. The lightning jumped from the cable to these steel braces, pierced the roof of the building, opening a jagged hole about 18″ x 24″, and then without burning the roof boards jumped about 18 inches to the end of a line of sprinklers in the center of the room. The lightning traveled along the sprinkler lines, then jumped to a metal conduit, which passed near and almost touched the sprinkler piping. This conduit was the main power line supplying a group of sewing machines located on a long table running across the width of the building. It was on the table that the fire occurred, resulting in the burning of about 8 feet of one end of the table.

As evidence of the heat caused by the lightning charge at this point, it was noted that several metal stays used in corsets were melted together and the electric bulb in the light socket was melted without being broken. The excessive heat opened 63 sprinklers under the roof, although there was no fire present to affect any sprinkler other than those directly over the table. Two other sprinklers under the table were also opened by the fire.

Damage.

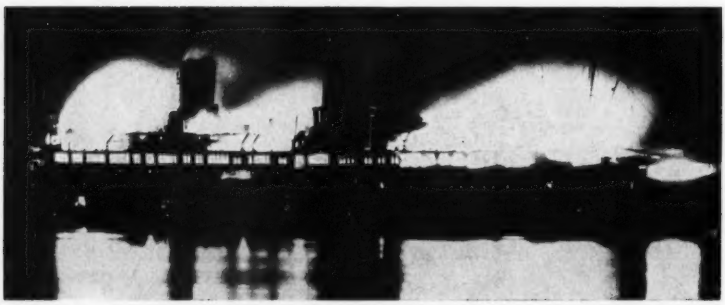
Fire damage was confined to the end of the long sewing table, which was badly burned. The lightning damage consisted of a shattered flagpole and the hole in the roof. Water damaged electrical equipment, the maple flooring on both floors and caused considerable loss through wet stock. The total loss is estimated to have been in the vicinity of $30,000.

S. S. Bermuda Fires.



International.

Twice within five months the new motor ship "Bermuda," one of the most luxurious liners sailing out of New York, has been swept by fire. The first fire occurred on June 17, 1931, in Hamilton, Bermuda. This fire resulted in a loss estimated at well over a million dollars and cost the life of one member of the crew.



International.

On the night of November 19, 1931, while under repair in a shipyard at Belfast, Ireland, fire was again discovered. The fire spread rapidly and as little could be done to combat the flames the ship was almost totally destroyed. The loss was estimated at $5,000,000. In both these cases, the fire started in the superstructure and swept the cabins and upper decks. Both fires occurred at the dock side with municipal fire-fighting equipment at hand to supplement the ship's own private protection.

Rowlesburg, W. Va., Oil Station Fire.

A gasoline and oil station fire at Rowlesburg, W. Va., on August 1, 1931, which resulted from a most unusual occurrence, furnishes an interesting example of the fire hazard of small community gasoline and oil distribution stations even where under careful and competent management. Gasoline and kerosene were stored in above-ground tanks, as is usual in properties of this character. The tanks were of modern gas-tight construction of a type which in themselves give no trouble, but no dikes or fire walls were provided to retain the liquid in case of its escape from the tanks.

At the time of the fire a gasoline tank truck was parked at a filling platform near the center of the property. For some reason the brakes failed to hold and the truck coasted off the platform, the rear bumper striking the discharge valve on a gasoline tank, causing a failure of the piping between the valve and the tank, thus allowing the gasoline to escape. The driver of the truck, showing unusual presence of mind and courage, drove a wooden plug into the broken pipe, stopping the flow of gasoline. A rubbish fire, however, was burning about one hundred and fifty feet away and the gasoline, which had already escaped, flowed to this fire where it ignited and flashed back, the burning gasoline on the ground soon increasing the pressure so that the wooden plug was blown out. The escaping gasoline burned and not being confined by any dikes or fire walls spread beyond the property, soon involving the lumber piles of an adjoining planing mill.

The accompanying diagram shows the layout of the property and the location of the adjoining lumber piles with respect to the tanks. The truck struck the valve on Tank No. 1, which at the time contained 17,000 gallons of gasoline. Tank No. 2 contained 9,000 gallons of gasoline, and No. 3 contained 3,000 gallons of kerosene. The entire contents of Tank No. 1 was burned, including that which escaped through the broken pipe and that which burned at the vent.

The safety vents at the top of the two gasoline tanks operated, the escaping vapors igniting and burning with an intense flame. The tanks themselves, each of 18,000 gallons capacity, were of standard steel construction and suffered comparatively little damage other than bulging. Only a fraction of the gasoline in Tank No. 2 was consumed. Tank No. 3 was not ignited.

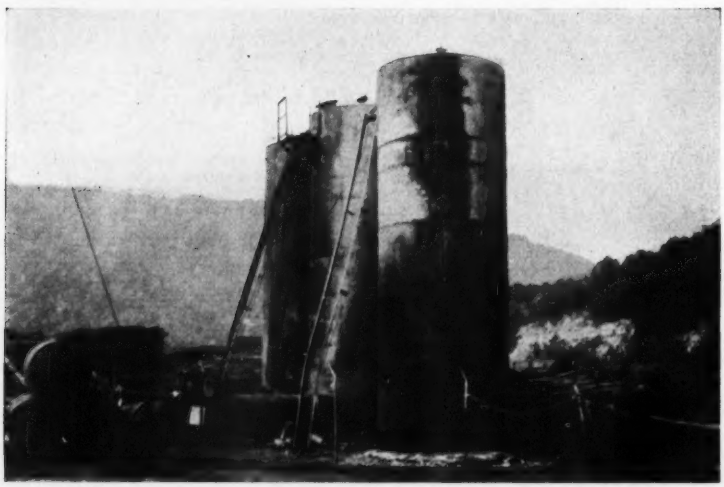
Rowlesburg had no facilities for coping with a gasoline fire. Practically no progress was made towards extinguishment until the escaped gasoline was

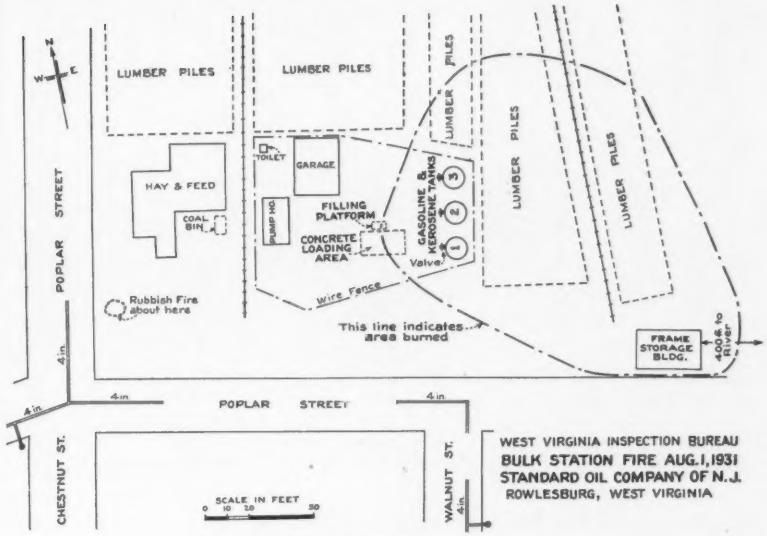
This report has been prepared from data supplied by the West Virginia Inspection Bureau (member N.F.P.A.), and by the Associated Factory Mutual Fire Insurance Companies (member N.F.P.A.).

Burning of gasoline vapor from the tank vents.

Where the tank truck ruptured the gasoline pipe.

View of tanks after the fire. Truck which caused the fire is in the foreground. The lumber piles are beyond and at the right of the tanks.





Map of burned area.

consumed. Aid was summoned from several communities including Oakland, Md., which sent a 600-gallon pumper, making a 30-mile run over a hill country in thirty-six minutes. The local volunteer fire department with 900 feet of hose on a reel, the pumper from Oakland and another 300-gallon pumper which came 24 miles, and a chemical and hose wagon with men from 12 miles away, did a very creditable piece of fire fighting, and aided by the absence of wind, prevented the fire from extending to the near-by planing mill and saved two million feet of lumber in storage, as well as exposed residences. Eight streams were used from $2\frac{1}{2}$-inch hose with $1\frac{1}{8}$-inch nozzles. The community water supply proved sufficient, some hose streams being taken from the direct pumping water system and pumpers taking suction from the near-by river. The fire was under control in $2\frac{3}{4}$ hours and completely extinguished 24 hours after it started. The total loss was estimated at approximately $50,000.

This fire indicates the desirability of dikes around tanks containing flammable liquids to retain the liquid in case of any rupture or leak. The desirability of adequate spacing between tanks and adjoining property, and protection of tank and piping against possible physical injury are also indicated. This fire likewise shows that ordinary fire protection facilities, even when well organized, are not sufficient to cope with flammable liquid fires and that where flammable liquid risks are involved adequate foam equipment should be available.

Springfield, Mass., Lodging House Fire.

An attempt to extinguish a fire without the aid of the fire department and inferior building construction were factors in a fire which occurred early on the morning of December 26, 1931, in the so-called New Court Hotel, a commercial lodging house, in Springfield, Mass. Eight persons lost their lives and many of the thirty or more other occupants of the building made their escape with difficulty over fire escapes, or were taken down ladders by firemen.

The New Court Hotel was a five-story structure with brick exterior walls and tinder-like wooden interior. It was located at the corner of East Court and Market Streets, having a frontage of approximately 140 feet on East Court Street, and a depth of 46 feet. The building was erected about thirty years ago. It had wooden floors and, except for two brick interior walls about eight feet apart and extending from the front to rear of the building, it had wooden partitions throughout. A structural feature forming a serious potential hazard was the air spaces along the vertical furring strips between the lath and plaster and the outer walls. The building was without fire stops. The open spaces between the furring strips extended from the cellar to the roof and their presence contributed to the rapid spread of the fire.

Egress from the building was provided by two stairways about fifty feet apart, on the long side of the building, leading from the top floor to East Court

International.

Ruins of New Court Hotel, Springfield, Mass. Showing damage wrought by fire which cost the lives of five occupants. Inferior construction and failure to call the fire department for what appeared to be an incipient fire were factors in this loss.

This report has been prepared from data furnished through the courtesy of Chief William H. Daggett and Building Commissioner Fred W. Lumis, Springfield, Mass. (Members N.F.P.A.)

International.

Fire sweeping through the New Court Hotel at Springfield, Mass. When firemen arrived the two upper floors were well involved and before hose streams could be brought into action the flames, fanned by a brisk wind, worked their way downward into the third floor.

Street. There were two outside fire escapes, one at either end of the building. All four means of egress were used by the occupants in escaping from the fire as well as ladders raised by the fire department. It is thought that those who lost their lives were rendered unconscious by smoke and gases before they could make any attempt to reach the exits. Those who reached the exits got to the ground in safety.

The building was not equipped with automatic sprinklers or with a standpipe. Fire extinguishers were provided in accordance with the regulations of the State Fire Marshal. The premises are said to have been kept free of accumulations of rubbish, for the building was recognized as a fire hazard, and periodic inspections had been made to safeguard its occupants as much as possible.

The first alarm for the fire was received by the fire department at 12:38 A.M. on December 26, 1931. When the firemen arrived after a short run, flames were issuing from the windows on the fourth floor, and the two upper floors of the building seemed heavily involved. A strong northeast wind fanned the flames, which spread rapidly, working their way downward into the third floor. The first efforts of the firemen were directed towards the rescue of the occupants, after which the fire was attacked and brought under control.

According to occupants of the building this fire was preceded by a smaller blaze which had occurred about a half hour earlier in an apartment on the

International.

Fire escape at south end of New Court Hotel. This escape was used by occupants of building in making their egress. Note that fire escape terminates on roof of store at second floor level and descent from this point is by fire department ladder, by interior stairway or by jumping.

fifth floor. This fire was presumably extinguished by the occupants or employees of the building with one or two soda-acid extinguishers. The later fire appears to have originated in the partitions on the fourth floor and it seems possible it may have been due to unextinguished embers from the first fire working their way into the hollow partitions or air spaces and dropping down to the floor below, where they were fanned into flames by the draft or air currents in the partitions. Whatever the cause, the fire had gained tremendous headway before the arrival of the fire department.

It is believed that at least thirty-three people were in the building when the fire broke out. Of these, all escaped but eight, who were apparently overcome by smoke or heat and trapped in their rooms. The victims included the janitor, his wife and two weeks' old child, who were overcome in their rooms on the fourth floor; the assistant janitor; and four others.

The building was badly damaged, being completely gutted above the third floor. The loss has been estimated to be in the vicinity of $100,000.

Berkeley, California, Gas Explosion.

An unusual explosion and fire, due to the ignition of escaping natural gas, occurred late in the afternoon on December 3, 1931, in a residence at Berkeley, California. The house itself was completely demolished and another was severely damaged. One bystander was instantly killed, forty-six others were injured or burned, and fifteen firemen were seriously hurt—two so badly that they died later.

The house in which the explosion occurred was built on the foundations of one destroyed in the conflagration of 1923. A gas service pipe entering the basement of the old house had been capped, and when the new one was erected a new service was introduced to supply gas for the furnace, water heater, and range. It was the old capped pipe which caused the trouble.

This report has been prepared from data furnished by Mr. Clarence Heller, member N.F.P.A.

Acme.

When gas, escaping from an uncapped pipe in the basement, ignited and exploded, this dwelling at Berkeley, Cal., was wrecked and burned. More than sixty firemen and bystanders were injured, three of them so severely that they later died.

Story of the Fire.

The odor of leaking gas had been apparent about the house for some time and the eighteen-year-old son of the owner and a boy companion went to the basement to investigate the source of the leak. They concluded that the gas was escaping around the cap of the disused pipe. They attempted to tighten the cap, but were unable to do so and accordingly gave it a turn in the opposite direction, intending to put white lead in the screw threads. The cap was turned a little too far and blew off. One of the boys endeavored to replace it, but was unsuccessful in the attempt because of the pressure of the gas and the fact that he was being overcome. The other, after vainly trying to turn off the pilot light in the gas furnace, ran out to find the shut-off valve near the meter. The first boy then ran upstairs to warn his mother.

When the escaping gas reached the pilot light a mild explosion occurred. This did little damage, but the gas from the uncapped pipe ignited and set the basement ceiling on fire. The fire department was called and the blaze was extinguished without difficulty. In the excitement neither of the boys thought to tell the firemen about the gas leak, and when the firemen extinguished the fire they also extinguished the gas flame from the uncapped pipe. The gas continued to flood the basement and the house, and thereupon the fire chief ordered the gas shut off at the meter. This was a logical thing to do, but while it shut off the pilot light in the furnace it did not check the flow of gas from the uncapped pipe, which was not connected to the meter. When the chief discovered this he ordered the pipe capped.

In the meantime windows and doors had been opened and a highly explosive mixture of gas and air had been formed. A spark or a smouldering ember ignited it and a terrific explosion resulted. The dwelling was wrecked, the

walls crumbled, and portions of the roof were hurled through the air in all directions. The adjoining house was badly damaged and a fire truck in front of the house was buried in the débris. Flames broke out in the wreckage.

The loss of life and injuries were a direct result of the explosion. The bystander who was killed was a student at the University of California who was watching the fire. He was struck in the face by a timber. The firemen who were killed and injured were inside the house at the moment of the explosion and could not make their escape before the building collapsed. The other injured persons, firemen and spectators, were struck by flying débris or burned by the blast of the explosion. An indirect loss of life due to the fire occurred when the father of one of the firemen, slightly injured by the explosion, passed away due to the shock of learning of his son's presence in the explosion.

Fires in Which There Was Loss of Life.

Since the publication of the October QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 138 reports of fires in which loss of life has occurred. While the number of fires reported to the N.F.P.A. is but a small fraction of the total number that have occurred during

Loss of Life Fires, October-December, 1931.

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	No. Fires	Lives Lost			
		Men	Women	Children	Total
Airplane fires	6	14	0	2	16
Apartments, lodgings, tenements, etc.	13	13	5	8	26
Automobile fires	12	10	6	1	17
Barns and sheds	3	1	0	2	3
Dwellings—Rural	39	9	15	32	56
Dwellings—Urban	27	19	10	11	40
Garages and filling stations	4	4	0	0	4
Industrial occupancies	5	5	0	0	5
Institutions	3	13	0	0	13
Mercantile	4	6	0	0	6
Mining property	2	9	0	0	9
Oil fields	1	1	0	0	1
Other buildings	5	6	0	0	6
Other than buildings	8	7	0	4	11
Public buildings	1	2	0	0	2
Railroad property	1	2	0	0	2
Response to alarms	3	3	0	0	3
Tank steamer	1	3	0	0	3
Total	138	127	36	60	223

This table is made up from reports received by the Department of Fire Record between October 1 and December 31, 1931. A few of the fires included herein occurred prior to October 1, but were not reported until after that date.

this period, the volume of data is sufficient to indicate the predominating causes of loss of life. A total of 223 lives were lost in the fires included in this tabulation.

Three institution fires were recorded involving a total loss of thirteen lives. The largest loss of life in an institution occurred on November 2, 1931, when fire destroyed a cottage ward of a hospital for insane at Penetang, Ontario. Nine male patients lost their lives in the fire. On December 14, 1931, a hospital for insane near Charlottetown, Prince Edward Island, was destroyed. Two patients were burned to death and a third was killed by jumping. More than three hundred other patients were led to safety by attendants, although the building was totally destroyed. The third institution fire occurred on December 15, 1931, in a Soldiers' Home in Washington, D. C., where one aged inmate died as the result of smoking in bed.

Causes of Loss of Life, October-December, 1931.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Cause	Men	Women	Children	Total
Airplane fires	14	0	2	16
Automobile fires	10	6	1	17
Children and matches	0	0	4	4
Cleaning with gasoline	0	1	0	1
Clothing ignited from gas stove or heater	2	2	1	5
Clothing ignited from bonfire or rubbish fire	1	0	4	5
Escaping from fire—drowned	1	0	0	1
Escaping from fire—jumped	2	0	0	2
Explosion—blow torch	1	0	0	1
Explosion—sewerage plant	2	0	0	2
Explosion—city gas	3	2	1	6
Explosion—gasoline lamp	0	0	1	1
Explosion—gasoline stove	1	0	0	1
Explosion—gasoline (no details)	2	1	1	4
Explosion—gasoline tank or tractor	2	0	0	2
Explosion—gasoline on tanker	3	0	0	3
Explosion—garage furnace	1	0	0	1
Explosion—illicit still	1	0	0	1
Explosion—kerosene lamp	2	1	0	3
Explosion—kerosene stove	1	0	0	1
Explosion—mine	9	0	0	9
Explosion—stove (no details)	1	2	2	5
Explosion—cause unknown	1	0	0	1
Fighting forest fire	1	0	0	1
Fire fighting	4	0	0	4
Gasoline used to start fire	1	2	2	5
Ignition of flammable liquids or vapors	6	3	0	9
Kerosene used to start fire	4	4	2	10
Overcome by smoke—suffocation	2	3	3	8
Railroad fires	2	0	0	2
Re-entering burning building	2	0	1	3
Responding to alarms	3	0	0	3
Shock or after effects of fire	4	0	0	4
Smoking in bed	6	1	0	7
Trapped in burning building	32	8	35	75
Total	127	36	60	223

An analysis of the loss of seventy-five lives recorded as "trapped in burning buildings" indicates that there were an unusual number of instances where the victims were children locked in the house while their parents were away.

Typical Loss of Life Fires.

Automobile Fire.

L-1369. PUTNAM, CONN., OCTOBER 24, 1931. A match carelessly thrown to the floor of an automobile started a fire which caused fatal injuries to two men. The match ignited a rug upon which gasoline had been spilled. The fire caused the driver to lose control of the car, which went over an embankment and turned over. The driver escaped with minor burns, but his two passengers were trapped and burned to death.

Children and Matches.

L-1358. BRISTOL, R. I., OCTOBER 9, 1931. A four-year-old girl was burned to death in the yard near her home when her clothing caught fire while she was playing with matches. Unknown to her parents she took matches from the kitchen to ignite a pile of papers in the yard.

Farm Fire.

L-1371. WARRENTON, VA., OCTOBER 27, 1931. Two men were burned to death and three were injured as a result of a fire which started when sparks from a threshing machine ignited a straw pile. The men attempted to save the threshing machine from the fire by means of a tractor. The heat from the fire caused the gasoline in the tractor to explode, resulting in the fatal burns.

Children Alone in the House.

L-1355. EAST NORTHPORT, L. I., OCTOBER 1, 1931. A nine-months' old child was burned to death while left alone at its home. The child's mother took her other children to school and the fire occurred while she was out. She was absent from the house only ten minutes.

L-1377. ALEXANDRIA, VA., NOVEMBER 6, 1931. A three-year-old child was locked in his home while his mother went out to watch a funeral procession. The child started a fire with matches. A five-year-old brother returned home and discovered the fire. But for locked doors, neighbors would probably have been in time to prevent the loss of life.

L-1399. BROOKLYN, N. Y., NOVEMBER 26, 1931. A year-old infant was burned to death in a fire which occurred while four children were left alone in their tenement home. The children were left at the dinner table while the mother went out to make a purchase. When she returned the building was in flames. The three older children had been saved by persons discovering the fire, but the baby died in his chair.